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# LOCOMOTIVE CYLINDER PROPORTIONS.

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In these days of railroad economies, where trains of such weight are hauled that, in the language of a prominent superintendent, "the engine would have stalled had a fly alighted on the train," and when trainmen will soon be instructed to "get off and push" over summits, it is of the utmost importance in designing a locomotive to take advantage of every pound allowable, in order to obtain the maximum tractive power possible under the given conditions. In order to realize this the coefficient of adhesion must be reached, but this is somewhat uncertain, its value, however, being generally fixed between 20 and 25 per cent., 22 per cent. probably indicating the ordinary friction between the wheels and the rails.

A committee of the Master Mechanics' Association in 1887 recommended a cylinder proportion which, at a mean effective pressure of 86 per cent. of boiler pressure, gave a coefficient of adhesion of 22 per cent. The value "86 per cent." hardly allows for the internal friction of the engine, which, if taken at 8 per cent., will give a "mean available pressure" of 80 per cent. of the boiler pressure. This would allow for a coefficient of adhesion of about 21 per cent. Improved sanding apparatus will, however, permit a value of 25 per cent. being reached, and perhaps more, but just how much is not definitely known. This evidently varies with the external conditions, as in some recent tests it was found necessary to use sand on curves when the net tractive power was only about 21 per cent. of the adhesive weight. The general tendency, at this time, is not to exceed 25 per cent. Angularity of the connecting rod in connection with the variation of steam pressure during the stroke, will increase the tendency to slip at certain angles of the cranks by from 10 to 15 per cent., but this may ordinarily be neglected.

In order to make comparisons more readily we can use the formula for the ratio of theoretical tractive power to adhesive weight:

$$R = \frac{P\,d^2\,s}{D\,W}$$

Where P=Boiler Pressure.
d=Diameter of Cylinder.
s=Stroke of Piston.
D=Diameter of Drivers.
W=Adhesive Weight, all expressed in pounds and inches.

In this case a ratio of 0.31 corresponds with 25 per cent. actual available power, allowing for drop in pressure, expansion and internal friction, as explained above.

Two years ago the writer, in connection with some committee work, collected a large amount of data concerning engines of different types in various parts of the United States and Europe. While in passenger locomotives the values of R varied between .22 and .34 as limits, the average value was .26, but one engine having a greater ratio than .30. The freight engines had .21 and .31 as limits, there being two with the latter value, the average being, however, .27. These figures refer to engines operated in the United States.

In European practice we find greater discrepancies; thus the passenger engines varied from .22 to .42 (the latter in Belgium), with an average of .28, while in freight service the ratios ran from .15 to .34, the average being .25. As above stated, these figures were collected about two years ago. Let us now see how these figures have been modified in the last year or two, in order to determine the general tendency on this point.

On page 296 of the September number of the "American Engineer" a table of recent heavy locomotives was given, and we will examine these, with the Chicago Great Western Mogul and the Great Northern 10-wheel passenger engine, comparing at first the simple engines only:

COMPARISON OF HEAVY LOCOMOTIVES.

| Railroad. | Builder. | Type. | Steam. | Cyl. | Wh'l. | Adhes. Wgt. | "R" |
|---|---|---|---|---|---|---|---|
| Mch. Central. | Brooks. | — | 180 | 21x26 | 49 | 145,000 | 29 |
| B. & O ...... | Pittsburgh. | Consol. | 180 | 22x28 | 54 | 152 800 | .2 ½ |
| D. M. & N.... | " | " | 160 | 22x28 | 50 | 144,0 0 | .30 |
| Buf. & Susq.. | Baldwin. | " | 180 | 22x26 | 51 | 147,300 | 31 |
| D. & I..... .. | Schenectady | — | 180 | 22x26 | 54 | 139 000 | .30 |
| Penna. (H-5).. | P. R.R. | Consol. | 185 | 23½x28 | 56 | 186,000 | .27½ |
| B. & M.. ..... | Pittsburgh. | " | 180 | 22x28 | 52 | 166.000 | .28 |
| Gt. Northern. | Brooks. | Mastodon. | 210 | 21x34 | 55 | 172,000 | 32½ |
| " | " | 10-Wheel. | 210 | 20x30 | 63 | 129.500 | .3 ½ |
| C. G. W....... | Richmond. | Mogul. | 200 | 19x28 | 60 | 100,000 | .33 |

It will be seen at once that there is a marked tendency to increase the ratio of tractive power to adhesive weight. There is no doubt that, as above mentioned, pneumatic sanders have been largely the means of permitting this increase, but it is still an open question whether ratios over .30 are desirable in new engines. As the wheels wear down and the cylinders wear large, the value of "R" will grow until, in the case of the C. G. W. mogul, with tires worn 1½ inches in thickness and cylinders bored out 1 inch larger, we have a ratio of nearly .39. Some recent tests with compound engines, in which R had a value of .37 when working simple, made it necessary to sand continally on straight track, while operating as a single expansion locomotive. Besides the great tendency to slip, we should consider the waste of steam and metal in tires and rails when slipping does occur, and we understand that some engines in which the value of "R" exceeds .30 are both slippery and heavy on fuel.

The value of "R" in compound locomotives of the two-cylinder type shows very great ranges. In order to be able to make a comparison with the figures just given for simple locomotives, let us substitute in our formula for "P," the value

$$\frac{\text{Boiler Pressure}}{\text{Cylinder Ratio}+1}$$ and the

diameter of low pressure cylinder for "d," when working compound, and let "P"=boiler pressure and "d"=diameter of high pressure cylinder, when working as a simple engine.

If we calculate the values of "Rc" and "Rs" (the ratio of theoretical tractive power to adhesive weight when working compound and simple respectively) we have for the C. G. W. compound mogul of the Richmond Locomotive Works, and the

Northern Pacific mastodon of the Schenectady Locomotive Works as follows:

| Railroad. | Type | Steam. | Cylinders. | Wh'l. | Ad. W't. | Rc. | Rs. |
|---|---|---|---|---|---|---|---|
| No Pacific. | Mastodon. | 200 | 23 & 34 × 30 | 55 | 150,000 | .26 | .38⅛ |
| C. G. W.... | Mogul.... | 200 | 21 & 33 × 28 | 60 | 100,000 | .29 | .41 |

The C. G. W. mogul is identical with the last engine in the former table, except in the matter of cylinders. We see from this that the two-cylinder compound locomotive as built will have "Rc" smaller and "Rs" greater than the same weight of simple engine. This is not always a disadvantage, nor on the contrary, is it in all cases a desired property. If the average grades are easy, and the simple operation is needed only for starting or passing short but heavy slopes, the combination obtained in this class of engine is perfectly logical, and the locomotive can be loaded satisfactorily to work compound during almost the entire trip. But should the engine be destined to work entirely on heavy grades, where the utilization of the total adhesion is of more value than the saving of 15 or 20 per cent. of fuel, and when the lever is kept constantly in the "corner," it will at once be evident that the advantage is with the simple engine, because to haul the same load the two cylinder compound would have to be operated in single expansion.

When the question of speed is considered, however, the compound (when worked as such) has the advantage, as a longer distance can be traveled with the same steam consumption, or what is the same thing, for a given boiler capacity (and weight) a higher average speed can be maintained. In some recent investigations it was calculated that a compound locomotive of the same adhesive weight as a simple engine, and with boiler 2 inches smaller at the front end, in order to allow for the extra weight of compound cylinders, would furnish steam for a speed of 15 per cent. greater than the simple engine, the compound cylinders being proportioned to give the same tractive effort as the simple cylinders. This is a point well worth considering, in designing and operating locomotives.

It must not be inferred from our remarks above that we are opposed to large cylinders; on the contrary, we have always advocated them of greater volume than most master mechanics have been willing to admit as the proper proportion, but at the same time different conditions require different treatment. For high speed passenger engines, where the large majority of work is done at an expansive ratio of 3, 4 or 5, we strongly favor cylinders that would easily slip the wheels if worked full stroke with a fair throttle opening, as this is undoubtedly the only way in which you can haul the heavy trains at a high speed. It is true that under such conditions there will be certain points or periods during each revolution where the pressure will be great enough to overcome the adhesion. Thus, at ⅛ cut off the maximum rotative force is 50 per cent. greater, and at ¼ cut off, 30 per cent. greater than the average rotative force during a whole revolution. But if the engine is running at a high speed, the inertia of the drivers, acting as flywheels, will probably be sufficient to resist the momentary application of this maximum force.

The same arguments do not apply, however, to freight engines as a general thing. The speed is ordinarily low—60 revolutions or so a minute—and if an attempt is made to operate with an early cut-off and a high average pressure, the maximum rotative forces, above referred to, would be almost sure to cause slipping at certain parts of the revolution. When at high speeds the inertia of the reciprocating parts tends to neutralize a high steam pressure at the commencement of the stroke, and to assist the low expanded pressure at the end of the stroke, so that the pressure is maintained more nearly constant on the crank, due to this fact, but at slow speeds the benefits of inertia are not apparent. Railroad managers uniformly insist upon an engine in freight service hauling every pound of which it is possibly capable, even though this be greater than the load for which it was designed. These various points indicate that the conditions under which freight engines ordinarily operate are not conducive to the use of large (relatively) cylinders and high expansive ratios. This is probably one reason that two cylinder compounds are rather more common in freight than in passenger service.

Along with the increasing size of cylinder has also come the long stroke. For years 24 inches was considered as a standard stroke for locomotives in this country, but now 26 and 28 inch strokes are common and 30, 32 and 34-inch strokes are making their appearance. There are several reasons why we have this increase in stroke. A very important one is that the clearances on many roads would not permit a cylinder of suitable diameter to give the necessary tractive force, to pass without striking, particularly in the case of the low pressure cylinders of 32 and 35 inches in diameter. Larger driving wheels have the advantage of keeping the large cylinders further from low obstructions, but this also necessitates larger cylinders. Then, again, some claim that with a large wheel and short stroke the distance through which the engine travels while the crank describes the portion of its revolution near the dead centre, when no rotative force from the piston reaches it effectively, is so great as to interfere seriously with its operation at slow speeds. The fact that pistons, rods and crossheads, as well as main rods and crank pins, can be made lighter, is also an argument in favor of long strokes, though the higher speed of reciprocating parts thereby made necessary certainly largely offsets the last claim. A long stroke on a comparatively small wheel brings the crank pin very near the rim, and the rods very close to the dirt of the track. The centrifugal force on the rods, tending to bend them in a vertical plane, is increased in proportion to the length of stroke.

If we wish to make a cylinder with the least amount of radiating surface for a given volume, the length should be equal to the diameter. Considering this property alone, we should not increase the stroke until the diameter reached the old standard value of 24 inches. Now as we have low pressure cylinders up to 35 inches in diameter, good proportions for a minimum amount of surface would require a longer stroke. This, and the fact that the side clearance is limited, will probably account for the gradual introduction of long strokes, but on general principles we think that the stroke should be kept down to from 1 to 1¼ times the diameter, unless it is impracticable to obtain the necessary clearance.

Our comparisons between cylinder power and weight have been made with the adhesive weights only, but the total weight is a matter of considerable importance. The weight of a locomotive, as a whole, is, or should be, primarily dependent upon the boiler and its contents, and correct designing requires all the parts of machinery and carriage to be as light as is consistent with strength—the boiler and its contents are alone intended to be heavy. Now the weight on drivers limits the load which can be drawn, but the boiler proportions limit the speed at which it can be operated when hauling the maximum load. If the boiler is small, we can haul as heavy a weight (provided, for the sake of argument, that the adhesive weight remains constant) as we can if the boiler be large, but the speed will be unsatisfactory. Now to increase the size and weight of the boiler without increasing the load on drivers (which may have reached its limit already, and probably has in the opinion of the Maintenance of Way Department) we must arrange for the increase to be carried on trucks. A two-wheel, or pony truck, carries, ordinarily, from 15,000 to 20,000 pounds, whereas a four-wheel truck can easily be loaded with double that amount. If now we consider the case of a mogul or consolidation engine, in which it was desired to increase the speed or work done, without placing any more weight on the drivers, we should have to take recourse to the 10-wheel, or mastodon type. Let us see what we should gain and lose by such a change. Suppose that we have had a consolidation locomotive with 150,000 lbs. on drivers and 20,000 lbs. on the truck; the boiler is 64 inches in diameter at the first barrel ring, and there are 263 tubes with 2¼ inches

outside diameter, the total heating surface being about 2,400 square feet.

If we redesign this engine, and substitute a four-wheel truck for the pony, we can increase the total weight of the engine 20,000 lbs. The new arrangement of truck will enable us to place our cylinders about 3 feet farther ahead of the driving wheels. This extra 3 feet in the length of boiler will give us 465 square feet more heating surface, or about 20 per cent. increase. The extra weight of this much boiler added will amount to about as follows, per foot of length:

| Boiler 64 inches diameter. | Lbs. | Boiler 68 inches diameter. | Lbs. |
|---|---|---|---|
| Tubes (263-2¼ inches)........ | 647 | Tubes (306-2¼ inches)........ | 753 |
| Shell ........................... | 480 | Shell ........................... | 560 |
| Water ........................... | 730 | Water ........................... | 825 |
| Total ......................... | 1857 | Total............................ | 2138 |
| or 83 lbs. per cubic foot. | | or 85 lbs. per cubic foot. | |

These figures consider the water as standing 4 inches above the highest part of the crown sheet, and the sheets are strong enough to carry 200 lbs. pressure per square inch. No allowance has been made for lagging or jacket.

The 3 feet in length of boiler will therefore increase the weight about 5,600 lbs., the extra length of frames about 900 lbs., and the four-wheel truck over the pony about 4,000 lbs., or a total increase of about 10,500 lbs. As we are allowed 20,000 lbs. increase by the substitution of the four-wheel truck, and have used but 10,500 lbs., so far, we can increase the size of the boiler by nearly 4 inches and this will give us 400 square feet more of heating surface, or a total increase of 865 square feet, or 36 per cent., with an increase in dead weight of 12 per cent. In addition to 36 per cent. (or thereabouts) increase in available steam capacity, we have the greater economy in fuel, owing to the reduced rate of combustion per square foot of heating surface, and from this we would expect a possible speeed of 14 miles per hour against 10 miles with the first engine. The extra weight of the engine would diminish the actual train load by 10 tons, but this is a small price to pay for the gain in speed.

If the engines under consideration were not loaded to their maximum adhesion, of course the extra steaming qualities would be an advantage for loads, as well as speeds. The application of just such considerations as we have outlined has been tersely expressed by a well known chief engineer of a Rocky Mountain road: "Experiment showed our engines to be very deficient in steaming power in all cases where they were called upon to overcome high resistance, at speeds over 12 or 15 miles per hour, and . . . . the length of train is determined by the ability of the engine to develop horse power, and is almost independent of the weight on the drivers. . . . . To sum up, the weight on drivers should be proportioned to the maximum rates of grades, while the steam making capacity should be proportioned to the average resistance and schedule speed, as an engine of given weight on drivers, designed to develop a given horse power, would utilize its full adhesion, under favorable conditions, while under other conditions it would utterly fail to develop sufficient horse power to utilize even 50 per cent. of the adhesion due to weight on drivers. We, therefore, expect to provide engines of greater horse power for the same weight on drivers."

## SHORT SMOKE BOXES FOR LOCOMOTIVES.

The design of locomotive smoke boxes is being considered carefully, and the present tendency is toward reducing their length, and instead of considering them as receptacles for sparks every effort is being made to render them self-cleaning, while of course the prevention of spark throwing is always in mind. Mr. J. Snowden Bell deserves a great deal of credit for this condition of affairs—for his efforts show that the long extension front was unnecessary and undesirable.

The advantages of short fronts may be stated as: First, the saving of weight; second, the saving of the cost of cleaning out the cinders; third, the improvement in steaming. The original idea of the extension was to get large areas for the netting, but this may be obtained as well with a short as a long extension. In the report on Exhaust Nozzles and Steam Passages before the Master Mechanics' Association in 1894 (page 112) it was stated that "an increase in the length of the smoke box over and above that necessary to get in a cinder pocket in front of the cylinder is unnecessary and undesirable, as the long smoke box greatly decreases the vacuum. Sufficient area of netting can be put into a smoke box which is long enough to give room for a cinder pocket in front of the cylinder saddle." Mr. Bell had already gone beyond this point, and did not see the necessity for the pocket at all. We show several designs in the accompanying engravings which may be considered as typical examples.

The Norfolk & Western arrangement, as submitted to the Master Mechanics' Association, while retaining the extension, has an important feature, in the line of self cleaning, in the location of the diaphragm and the use of the low nozzle. The idea is to obtain so even a draft on the flues as to avoid pulling the cinders into the front end. The diaphragm is brought down back of the steam pipes and then carried horizontally to the front, and the netting is confined entirely to the extension. Two petticoat pipes are used to equalize the draft, and the lower one is carried down very near to the top of the nozzle. This front end cleans itself and does not throw sparks.

It is evident that the extension not only serves no purpose in this design, but also is opposed to its principle, and it probably appears only because the application was made to an engine already fitted with it. If the smoke box is to be cleared, as is the object of the design, there is obviously no reason for providing a receptacle for sparks, and the vertical portion of the deflecting plate could be set back to the line of the smoke box proper, or even closer to the nozzle, and do its work just as it does in the design as shown. There need only be sufficient space on front of it for the passage of the products of combustion, and the two-thirds or more of the length of the extension, which is now unnecessary, could be dispensed with.

The construction used on the Michigan Central Railroad, in which no cinder pocket is employed, and which is reported to be a satisfactory self cleaner, embodies the same general features, i. e., low nozzle and the bottom of the deflecting plate located in front of the nozzle, as the Norfolk & Western, and, like it, presents the incongruity of a long extension, which is unnecessary, either as a cinder receptacle or a space for netting.

Mr. W. P. Coburn, Assistant Master Mechanic of the Chicago, Indianapolis & Louisville, devised the arrangement shown in Fig. 2. It employs a deflector plate extending down in front of the nozzle, and this throws the sparks down to the front corner of the smoke box, and in passing upward they come into contact with projections upon the inside of the front end door and the door casting, grinding them to powder. When they pass to the stack they go through a netting that is nearly vertical. This arrangement makes it possible to reduce the extension to 15 inches. The sparks are extinguished before they go out, and the arrangement has been so satisfactory that it is being applied to all engines on the road. Mr. Coburn informs us that the steaming qualities of the engines are improved, and also a material saving in fuel is effected.

The design shown in Fig. 3 is by Mr. J. S. Turner, Superintendent of Motive Power of the Union Pacific, Denver & Gulf, and formerly Superintendent Motive Power of West Virginia Central & Pittsburgh Ry. This front end is self-cleaning and is moderately short. Mr. Turner, in a letter written while Superintendent of Motive Power of the West Virginia, speaks of his work on short front ends on that road as follows:

"We have not made any special tests to determine the relative efficiency of this device, as compared with the arrangement most commonly used, but from personal observation we find the locomotives steam more freely, and examination

of our performance shows a saving in fuel. The advantages of the short self-cleaning front end are: (1) Reduction in the length of front end and discarding spark hopper. (2) Bottom steam pipe joints and bolts, cylinder saddle strengthening sheet and saddle bolts, and front end ring and door will not burn and warp, as it completely prevents an accumulation of hot sparks or cinders. (3) No delay on the road caused by stopping to clean front end, and no cleaning at terminals, consequently preventing dust and sparks getting in the truck boxes, and blowing over the locomotive and machinery. (4) Prevention of fires to property along the road. (5) Locomotives will steam more freely and show economy in fuel.

"All of the above advantages will reduce expense. This front end is being applied to all new engines, while a modification is used in repair work when the old rings are in good order. Credit must be given Mr. Bell for the shortening up of the extension, but the arrangement of diaphragm plate and netting, as shown in Fig. 2, is the result of the writer's experimenting on the Mexican Central, and also on this road."

It is evident that Mr. Turner should share in the credit for the improvements in front ends that are indicated in present practice.

The front ends, designed by Mr. J. Snowden Bell, of Pittsburgh, are shown in Figs. 4 to 6. Fif. 4 is a very short front, applied in 1897 to a 10-wheel engine, with 20 by 24-inch cylinders, on the Baltimore & Ohio. The deflecting plate near the ends of the tubes is punched with lips projecting toward the front from the holes. A sheet of netting prevents cinders that may pass through the deflector plate from going directly into the stack, while the main portions of the netting are in three intersecting planes in front of the nozzle. A small opening is left between the first two nettings in order to allow cinders to drop back into the lower space instead of clogging the angle of the nettings. A sheet of netting below the opening prevents the direct egress of sparks. The deflector plate directs the current of sparks to the front lower portion of the smoke box, where they come into contact with a corrugated plate supported by fire clay. This front end cleans itself, and the engine steams very freely without throwing sparks.

The Great Northern 12-wheel freight engines, illustrated in our January, February and March issues of the current volume, have the Bell arrangement shown in Fig. 5. These

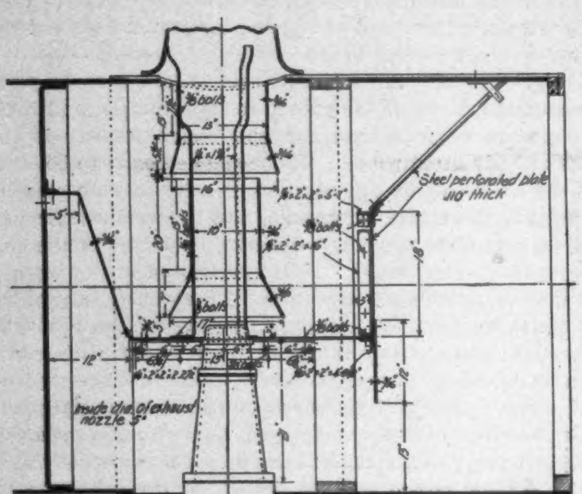


Fig. 1.—Norfolk & Western.

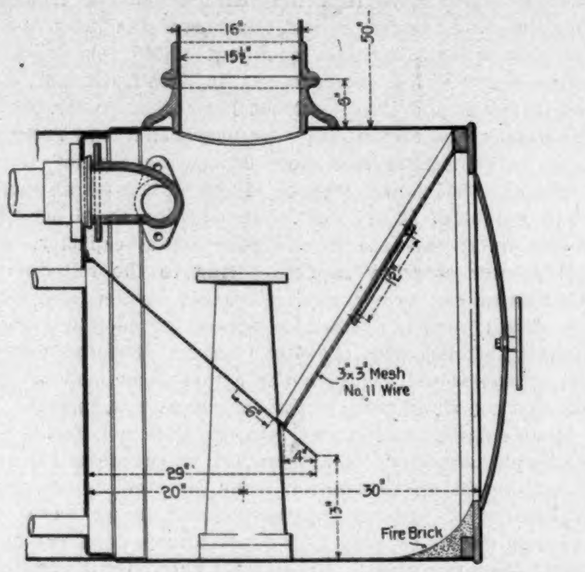



Fig. 3.—West Virginia Central & Pittsburgh.

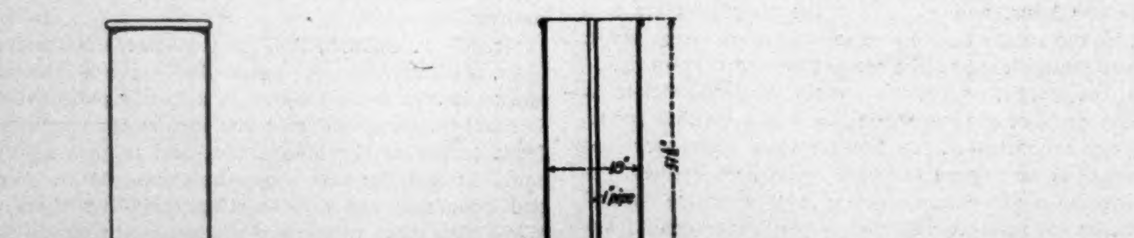



Fig. 2.—Coburn's Arrangement, Chicago, Indianapolis & Louisville.

SHORT SMOKE BOXES FOR LOCOMOTIVES.

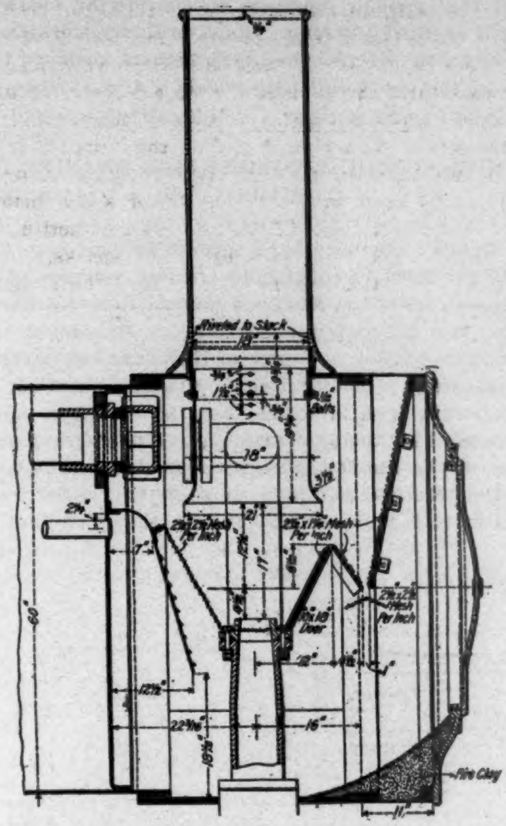



Fig. 4.—Baltimore & Ohio.

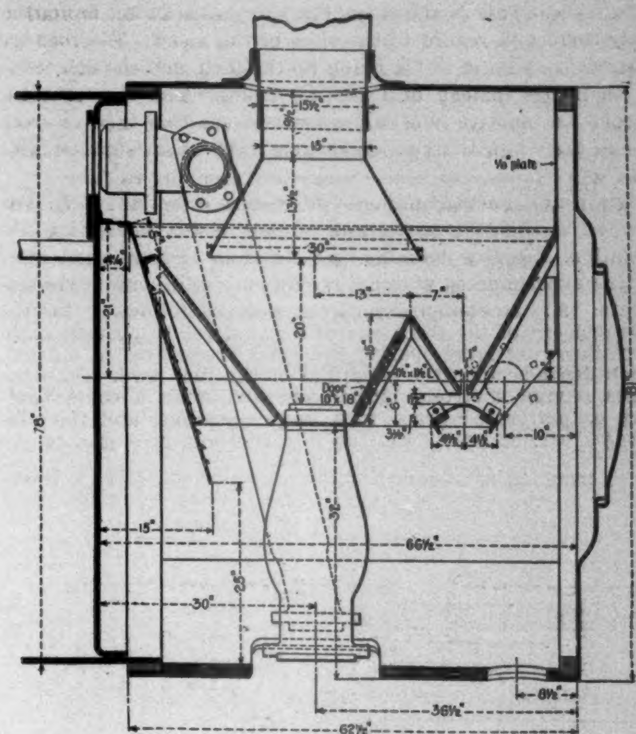



Fig. 5.—Great Northern.

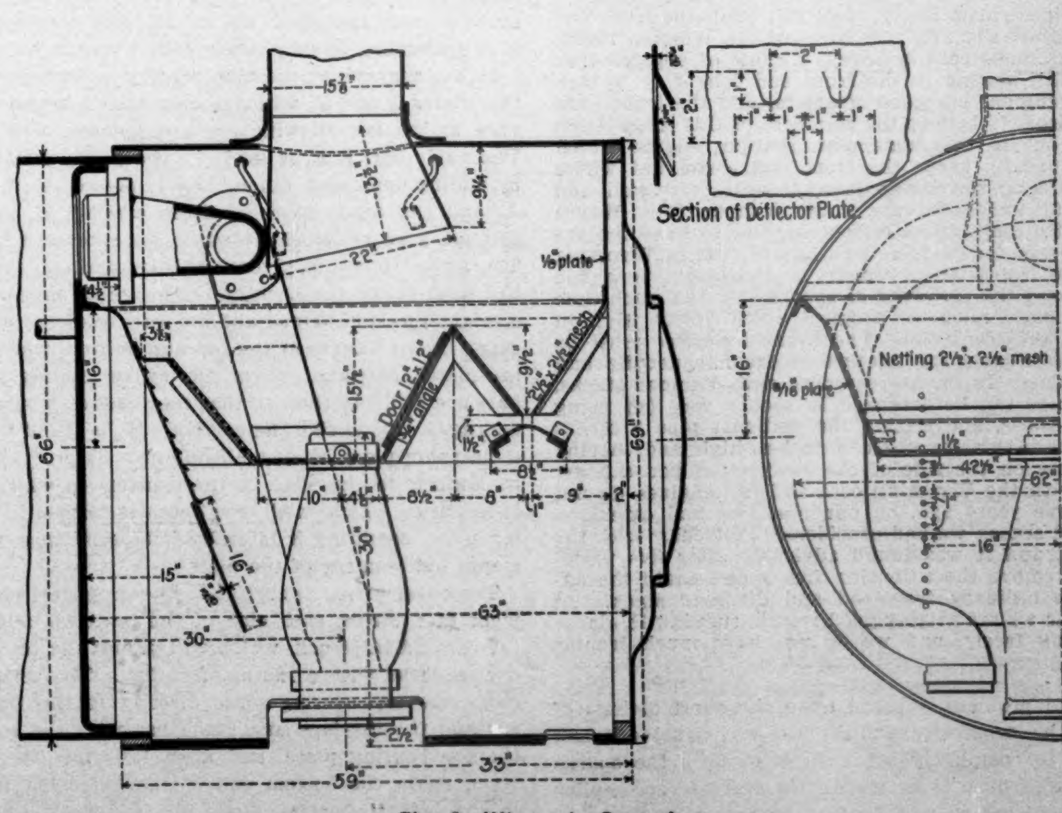



Fig. 6.—Wisconsin Central.

J. SNOWDEN BELL'S PATENT
SHORT SMOKE BOXES FOR LOCOMOTIVES.

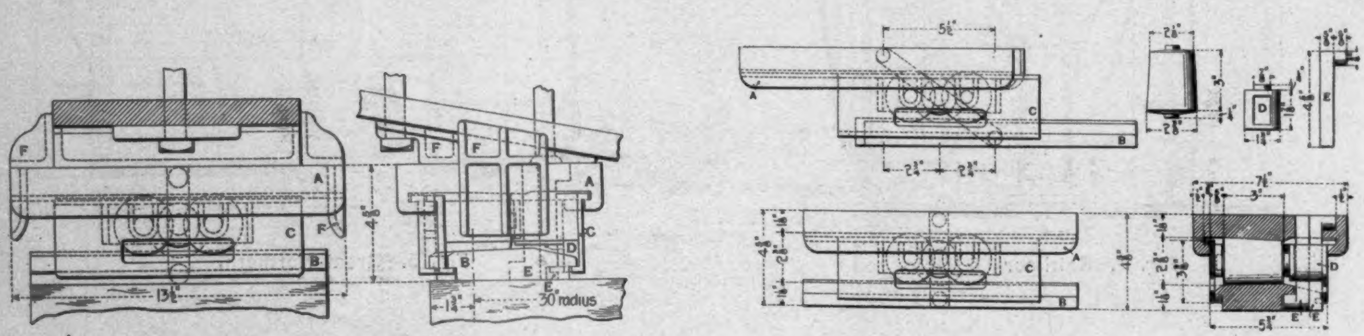
engines were built by the Brooks Locomotive Works, and the reports are very satisfactory. The same general plan, with a slightly improved arrangement, was used on the Wisconsin Central passenger engines, illustrated on page 192 of our June, 1898, issue. This is shown in Fig. 6. The drawing is not exactly correct in regard to the sizes of the mesh. The forward portion has a mesh of 2¼ by 1¼ to the inch, and the door is 12 by 18 inches instead of 12 by 12 inches. The fact that the Brooks Locomotive Works continue to use this type of front end in their new designs is evidence of their satisfaction with it.

The Union Pacific method was described by Mr. J. H. McConnell at the 1898 convention of the Master Mechanics' Association. He uses diamond stacks and short front ends, after having experimented with a large number of different arrangements. Mr. McConnell's remarks were as follows: "In the arrangement of the front end of locomotives to prevent them from throwing large sparks, and clear themselves of cinders, much depends upon the condition of the fuel used. On some roads having a strong bituminous coal, with a coarse netting or perforated grate with large openings, and the diaphragm carried pretty well up into the bottom of the smoke box, if the engines steam freely, they will clean the front end and still not throw any fire. On some of the Western roads, where the bituminous coal is heavy, I know of engines that are running with netting in the front end 2 by 2 or ½-inch opening. The engines are good steamers, and the front ends are perfectly clean. I believe the members of this Association will bear me out in this statement, that an engine which steams freely usually keeps the front end clean, but where the front end fills up the engine does not steam very well, and where it does fill up the engine is apt to throw fire. Where you use a lignite coal, it is a difficult matter to have the engine clean and not throw fire. The lignite coal in Wyoming is much of the character of wood. It requires a very fine netting to prevent the throwing of sparks. At the same time the deflecting plate must be dropped down pretty well, in order to clean the front end. The exhaust nozzles must be contracted to overcome the friction of the fine netting and the deflecting plate. In engines equipped with diamond stacks, the petticoat pipe can be arranged in such a way (by using rather large nozzles, and setting the petticoat pipe 2 inches above the nozzles, placing them 4 inches high and leaving a 5-inch opening on the side of the stack) that you can get good results with the Wyoming coal and the engines do not throw fire. Some years ago, on our road, we had extension fronts, and that season we had considerable difficulty with the Wyoming coal, and it was found advisable after five years' experience to remove the extension fronts and equip the engines with the ordinary front-end and diamond stack. At the present time we are getting good results running the large nozzle, steaming freely, and we do not have much trouble with fire."

The front-end problem is based upon the shortcomings of other parts of the locomotive, and the best way to solve it, and the only way to completely settle it, is to keep the sparks in the firebox and burn them there. In order to accomplish this the firebox, grates and heating surface must be considered, as well as the front end. The losses from sparks are not to be neglected, and it is not sufficient to merely provide for getting rid of them after they leave the fire box. Professor Goss has shown (see American Engineer, October, 1896, page 255) that popular judgment in considering spark losses to be small is entirely wrong. Under ordinary working conditions in common practice they may amount to more than 10 per cent. of the fuel value of the coal.

## THE NEW SUSEMIHL-TORREY SIDE BEARING FOR CARS.

In our October number of the current volume, page 339, we illustrated the form of roller side bearing, with which all of the passenger cars of the Michigan Central Railroad have been fitted, and now through the courtesy of Mr. Robert Miller, Superintendent of Motive Power of that road, we present engravings showing a modification of the same idea for application to freight cars, in which there is less room vertically than is required for the passenger type. The engravings show two forms of the bearing, with sections and details to illustrate its construction, and it is apparent that much less vertical head room is required than in the other form, but where there is room enough to get in the form previously illustrated it is preferable, having larger rollers and fewer parts.



The New Susemihl-Torrey, Low Roller Side Bearing.

In the engravings the new bearing is seen to consist of the two plates A and B, with the carriage, C, between them. The view at the left showing the arrangement with the bolsters. The guide bar, E E, is made in two parts, which may extend by sliding upon each other. One is pivoted to the top casting, A, and the other to the bottom casting, B, and both pass through a swivel block, D, which has mortise to receive them. The swivel block is pivoted in the carriage, C, and controls the position of the carriage. The guide bars are held in a straight line and extend and contract telescopically. The carriage, C, has flanges at the top and bottom, whereby the bearing plates, carriage, rollers, the swivel casting and the guide bars are held together, so that they cannot separate or become deranged. To enable the car body to be lifted from the truck a clamping plate, F, of malleable iron is provided and shaped to conform to the pitch of the transom to which it is bolted. It has arms which catch over recesses formed in the top bearing plate, confining it laterally but permitting vertical movements independent of the plate.

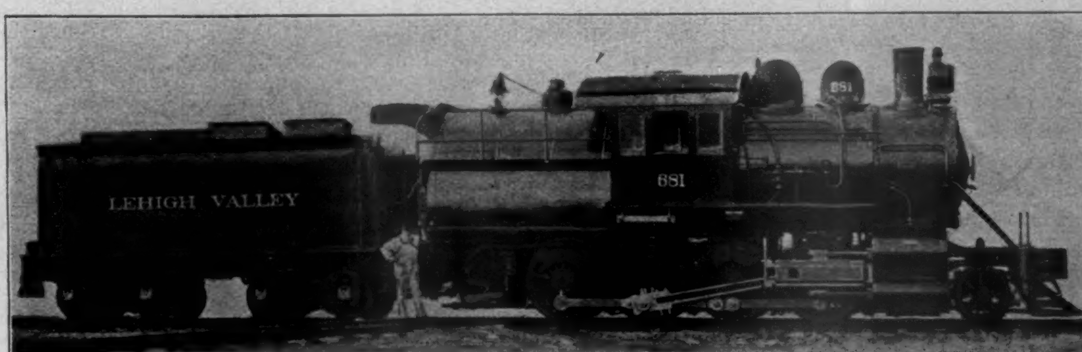
The construction is such that in cars 34 feet long a displacement of 6 inches each side of the center is allowed between the car and the truck, which will permit the car to turn freely over a curve with a radius of 60 feet. The earlier design secures the top bearing plate directly to the transom of the car and the carriage and guide bar with the rollers go with the top bearing plate, and upon lowering the car upon the truck again the bottom end of the guide bar finds its place in the bottom bearing plate. It is difficult to see how any other arrangement can be made whereby the bearing can be kept within a vertical height of 4⅝ inches, as is the case in this design.

## CONSOLIDATION PUSHER LOCOMOTIVE, LEHIGH VALLEY R. R.—VAUCLAIN COMPOUND.

Through the courtesy of Mr. S. Higgins, Superintendent of Motive Power of the Lehigh Valley, we have received a photograph and extracts from the specifications of a very large and heavy pushing engine, recently built by the Baldwin Locomotive Works.

The engine is to work on that portion of the road known as the "Mountain Cut Off," extending from Coxton to Fairview, where there is a grade of 62 feet per mile and 20 miles long. The engine was designed to haul 1,000 net tons, exclusive of the engine and tender, and to handle such loads over this grade at a speed of 17 miles per hour with a good quality of "buckwheat" coal for fuel. The engine is to make the trip between Coxton and Fairview without stopping to take water. The limiting clearances were 10 feet 3 inches in width and 15 feet 4 inches in height.

The conditions imposed were severe, requiring very high tractive power and an enormous boiler capacity. The consolidation type was selected, and the weight on drivers is 202,282 pounds. The engine is therefore next to the heaviest ever built, and for heating surface, we believe, surpasses every engine now in service. The firebox is of the Wootten type, with 90 square feet of grate area. The boiler is 80 inches in diameter, and it contains 511 tubes 2 inches in diameter and 14 feet 7 inches long.




**Compound Consolidation Pushing Locomotive, Lehigh Valley R. R.**

VAUCLAIN SYSTEM. BALDWIN LOCOMOTIVE WORKS.

The heating surface is 883 square feet greater than that of the Carnegie engine, illustrated on page 365 of our November issue. The cylinders of the Lehigh Valley engine are arranged on the Vauclain compound principle, and are 18 and 30 inches in diameter by 30 inches stroke. In addition to the enormous boiler capacity, the fact that the engine is a compound is most interesting, and that such a powerful machine should be compounded is a significant fact. Moreover, it is a four cylinder compound, and we do not see how any but the four cylinder could be used in such a design. It may be predicted that interesting history on the general subject of compound locomotives will be made with this engine, and its operation will be closely watched.

The weight per driving wheel is 25,300 pounds, which is exceeded by only one engine now running, the one already referred to. The total weight of 346,000 pounds is 12,000 pounds more than the Carnegie engine, and the wheel base is very nearly the same. This increase is partly due to the very large tender. The driving axle journals are 9 by 12 inches, and the drivingwheels are 55 inches outside the tires. The tender has Fox pressed steel trucks.

The following table gives the chief dimensions of the engine:

| | |
|---|---|
| **Cylinders.** | |
| Diameter (high pressure) | 18 in. |
| Diameter (low pressure) | 30 in. |
| Stroke | 30 in. |
| Valve | Balanced piston. |
| **Boiler.** | |
| Diameter | 80 in. |
| Thickness of sheets | ⅝ in. |
| Working pressure | 200 lbs. |
| Fuel | Hard coal |
| **Firebox.** | |
| Material | Steel |
| Length | 120 in. |
| Width | 108 in. |
| Depth | Front, 62⅝ in. |
| " | Back, 60½ in. |
| Thickness of sheets | Sides, ⅜ in. |
| " " | Back, ⅜ in. |
| " " | Crown, ½ in. |
| " " | Tube (F), ⅝ in. |
| " " | Tube (B), ½ in. |
| **Tubes.** | |
| Number | 511 |
| Diameter | 2 in. |
| Length | 14 ft. 7⅝ in. |
| **Heating Surface.** | |
| Firebox | 215. sq. ft. |
| Tubes | 3890.6 sq. ft. |
| Total | 4105.6 sq. ft. |
| Grate area | 90. sq. ft. |
| **Driving Wheels.** | |
| Diameter outside | 55 in. |
| Diameter of center | 49 in. |
| Journals | 9x12 in. |
| **Engine Truck Wheels.** | |
| Diameter | 36 in. |
| Journals | 6x12 in. |
| **Wheel Base.** | |
| Driving | 15 ft. 0 in. |
| Total engine | 23 ft. 10 in. |
| Total engine and tender | 55 ft. ½ in. |
| **Weight.** | |
| On drivers | 202,232* |
| On truck | 22,850* |
| Total engine | 225,082* |
| Total engine and tender | 346,000* |
| **Tender.** | |
| Diameter of wheels | 33 in. |
| Trucks | Fox Pressed Steel. |
| Journals | 5 ft. x 9 in. |
| Tank capacity | 7,000 gals. |
| Weight, empty | 45,250 lbs. |

*Weight includes water in boiler.

## "ALL WORK FOR NOTHING."

The characters in the following exciting story, sent us by the Signal Engineer of one of the trunk railroads, are a Germo-Russo-Swede and his wife. The scene is laid at a double track drawbridge, combined with a grade, a bad curve and an interlocking plant, with derailing switches. The combination foreigner is the bridge and signal tender and the wife is his strategic board and adviser. The engine ran to the brink of the river and then turned over, with the pilot overhanging the edge. Had it not been for the noise made by the "Wif," there is no telling what would have happened.

The Story.

Signal Engineer, ——— Ry.:

Dear Sir: I have to reporten that yesterday Evening the train, Engine No. 845, run off from the trak. I have to opnen the Bridge, and I heare and see nothing from a approachen train, and so I pulled the delairing Switch, and I have the Bridge open about 8 or 10 Feet, as I heare the train Signal for go ahead, so I sended my Wif back for making noise and give Signal to stop, she cam 500 Feet, as she see's the train Commen along, as Engineer give a Signal to stop, but was all work for nothing. A. STRACHJCKELSKIYONSON,
Bridge tender.

[The name is fictitious, being a mild form of the original, but otherwise the report is fac simile. No comment is necessary.—Editor.]

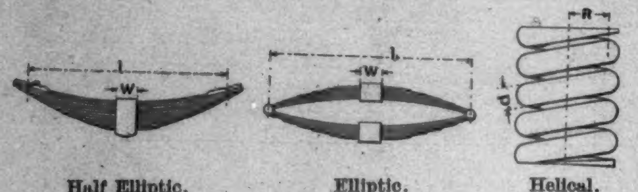
## LOCOMOTIVE DESIGN—THE WORKING STRENGTH OF MATERIALS.

By F. J. Cole,
Mechanical Engineer Rogers Locomotive Works.

### SPRINGS.

In designing elliptic springs for locomotives, experience shows that the best results are obtained by the use of a fibre strain in the hardened steel plates of from 70,000 to 80,000 pounds per square inch, figured from the static load. The former is desirable when the springs are unusually long, say over 44 or 46 inches, and the latter for springs shorter than 34 inches between centers of hangers, the aim being, of course, to make the most durable spring consistent with a soft, slow and easy motion. Some years ago on one of the large railroads, in order to reduce the excessive breakage and failure of locomotive driving springs, a large number were made with a fibre stress of 60,000 pounds per square inch, calculated from the static load they were to carry. While the results were satisfactory regarding their durability, yet the flexibility, or elasticity, was reduced below the point of easy motion, and complaints of rough riding engines became so numerous and persistent, that it was decided to increase the nominal or static stress to 75,000 pounds. This proved to be satisfactory from both the standpoint of durability and easy motion.

The weights on the driving wheels, resting upon the rails were obtained from all classes of engines on the road, and proper deductions made for the weight of parts not borne by the springs—such as wheels, boxes, eccentrics, rods, etc.—and the correct loading for each spring obtained. Then the proper




Half Elliptic. Elliptic. Helical.

**Springs.**

amount of metal was allowed for each spring, consistent with its length, load, width, etc., and the fibre stress of the metal kept as near the desired figure as practicable. For short springs it was found desirable to increase this to 80,000 pounds, and for springs of, say 42 inches and over, a soft, easy motion could be obtained with a fibre stress of 70,000 pounds. With these facts in view the spring business on the road was thoroughly gone over and systematized. The results obtained were a decided improvement in durability and easy motion. The number required for stock was very much reduced, as many of them differed but little from others and by making very slight changes in a number of instances the same spring could be used on several different classes of engines.

The following formulæ will be found useful in calculating the fibre stress and deflection of elliptic springs, in which:

l = length of spring between centers in inches.
W = width of spring band.
n = number of plates in spring.
S = fibre stress in plates per square inch = 75,000 pounds.
P = load carried by spring (static).
b = width of plates.
E = modulus of elasticity = 30,000,000 pounds.
D = deflection of spring in inches.
h = thickness of plates.

$$P = \frac{2\,s\,b\,h^2\,n}{3\,(l - w)} \text{ reducing to } \frac{4{,}880}{l - w} \text{ when } h = \tfrac{5}{16} \text{ inch.}$$

$$\text{"} \quad \frac{7{,}080}{l - w} \quad \text{"} \quad h = \tfrac{3}{8} \text{ inch.}$$

$$\text{"} \quad \frac{9{,}570}{l - w} \quad \text{"} \quad h = \tfrac{7}{16} \text{ inch.}$$

$$\text{"} \quad \frac{12{,}500}{l - w} \quad \text{"} \quad h = \tfrac{1}{2} \text{ inch.}$$

When b and n = 1.

$$S = \frac{3\,P\,(l - w)}{2\,b\,h^2\,n}$$

$$\text{For half elliptic } D = \frac{3\,P\,(l - w)^3}{8\,E\,b\,h^3\,n}$$

$$\text{For full elliptic } D = \frac{3\,P\,(l - w)^3}{4\,E\,b\,h^3\,n}$$

The following table has been calculated from these formulae for a uniform fibre stress of 75,000 pounds, 4 inches width of band and 1 inch width of plate. By its use the number of plates required can be obtained for a given length, width, and thickness, by multiplying the load in the column corresponding to the thickness of plates and length between centers, by the required width of plate, and dividing the product so obtained into the load the spring has to carry, the quotient will be the number of plates. Example: How many plates should a half elliptic spring contain, 36 inches long, ⅜ inch plate and 3½ inches wide, to carry 12,300 pounds?

$$\frac{12300}{220 \times 3\frac{1}{2}} = 16 \text{ plates, Deflection 1.71 inches.}$$

For the ordinary lengths of locomotive springs, plates ⅜-inch thick are generally used. When they are very short, 5-16-inch thick can be used to better advantage, as a greater deflection can be obtained with a given fibre stress. Plates 7-16 inch and ½ inch will be found useful for long springs and in special cases, where the width is narrow, it is advisable to reduce the height and number of plates.

### TABLE NO. 1.

**Loads and Deflections for Half-Elliptic Springs.**
Fibre stress = 75.000 pounds per square inch.
For full elliptic springs the deflection is twice that given in table.
All spring bands four inches wide.
For bands three inches wide assume the spring to be one inch longer.

| Length Between Centers. | —One 5-16 by— 1 in. Plate. Load. | Deflection. | —One ⅜ by— 1 in. Plate. Load. | Deflection. | —One 7-16 by— 1 in. Plate. Load. | Deflection. | —One ½ by— 1 in. Plate. Load. | Deflection. |
|---|---|---|---|---|---|---|---|---|
| 20 | 305 | .51 | 439 | .43 | 598 | .36 | 781 | .32 |
| 21 | 287 | .58 | 413 | .48 | 563 | .41 | 734 | .36 |
| 22 | 271 | .65 | 390 | .54 | 532 | .46 | 694 | .40 |
| 23 | 257 | .72 | 370 | .60 | 504 | .51 | 658 | .45. |
| 24 | 244 | .80 | 351 | .67 | 478 | .57 | 625 | .50 |
| 25 | 232 | .88 | 335 | .73 | 456 | .63 | 595 | .55 |
| 26 | 222 | .97 | 319 | .81 | 435 | .69 | 568 | .61 |
| 27 | 212 | 1.06 | 306 | .88 | 416 | .75 | 543 | .66 |
| 28 | 203 | 1.11 | 293 | .96 | 399 | .82 | 521 | .72 |
| 29 | 195 | 1.22 | 281 | 1.04 | 383 | .89 | 500 | .78 |
| 30 | 188 | 1.34 | 270 | 1.13 | 368 | .96 | 481 | .84 |
| 31 | 181 | 1.46 | 260 | 1.21 | 354 | 1.04 | 463 | .91 |
| 32 | 174 | 1.57 | 251 | 1.30 | 342 | 1.12 | 446 | .98 |
| 33 | 168 | 1.68 | 242 | 1.40 | 330 | 1.20 | 431 | 1.05 |
| 34 | 162 | 1.80 | 234 | 1.50 | 319 | 1.28 | 417 | 1.12 |
| 35 | 157 | 1.92 | 227 | 1.60 | 309 | 1.37 | 403 | 1.20 |
| 36 | 152 | 2.05 | 220 | 1.71 | 299 | 1.46 | 391 | 1.28 |
| 37 | 148 | 2.18 | 213 | 1.81 | 290 | 1.55 | 379 | 1.36 |
| 38 | 143 | 2.31 | 207 | 1.92 | 281 | 1.65 | 368 | 1.45 |
| 39 | 139 | 2.45 | 201 | 2.04 | 273 | 1.75 | 357 | 1.53 |
| 40 | 135 | 2.59 | 195 | 2.16 | 266 | 1.85 | 347 | 1.62 |
| 41 | 131 | 2.74 | 190 | 2.28 | 259 | 1.95 | 338 | 1.71 |
| 42 | 128 | 2.89 | 185 | 2.41 | 252 | 2.06 | 329 | 1.80 |
| 43 | 125 | 3.04 | 180 | 2.53 | 245 | 2.17 | 320 | 1.90 |
| 44 | 122 | 3.20 | 176 | 2.67 | 239 | 2.28 | 312 | 2.00 |
| 45 | 119 | 3.36 | 171 | 2.80 | 233 | 2.40 | 305 | 2.10 |
| 46 | 116 | 3.52 | 167 | 2.94 | 228 | 2.52 | 298 | 2.21 |
| 47 | 113 | 3.70 | 164 | 3.08 | 222 | 2.64 | 291 | 2.31 |
| 48 | 111 | 3.87 | 160 | 3.22 | 217 | 2.76 | 284 | 2.43 |
| 49 | 108 | 4.05 | 156 | 3.37 | 213 | 2.89 | 278 | 2.53 |
| 50 | 106 | 4.23 | 153 | 3.52 | 208 | 3.02 | 272 | 2.64 |

Probably 75 per cent. or more of all locomotive driving springs are made of plates 3½ inches wide by ⅜ inch thick.

Table No. 2, therefore, has been prepared, giving the working loads for lengths between centers of hangers from 20 to 50 inches, and for the different numbers of plates ranging from 4 to 26. The deflections for the various lengths are given in table No. 1.

From table No. 2 the working load for a spring of given length and number of plates, or for a given load and length, the number of plates required, may be obtained without any calculation.

In a general way it may be stated that for ordinary weights of locomotives and conditions of track, the deflection for driving springs should not be made less than 1½ inches for smooth, easy riding. This would mean that when the conditions are observed under which the table is constructed, half elliptic springs of less than 33 or 34 inches long, when made of ⅜-inch steel, or 31 to 32 inches long, when made of 5-16-inch steel, should not be used.

TABLE NO. 2.

Working Loads for Half Elliptic Springs. Plates 3½ Inches wide by ⅜-inch Thick. Bands, 4 Inches Wide.

| Length between Centers. | Number of Plates. | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 20 | 6,146 | 7,682 | 9,219 | 10,735 | 12,292 | 13,828 | 15,365 | | | | | | | | | | | | | | | | |
| 21 | 5,782 | 7,227 | 8,673 | 10,118 | 11,564 | 13,009 | 14,455 | 15,900 | | | | | | | | | | | | | | | |
| 22 | 5,460 | 6,825 | 8,190 | 9,555 | 10,920 | 12,285 | 13,650 | 15,015 | 16,380 | | | | | | | | | | | | | | |
| 23 | 5,180 | 6,475 | 7,770 | 9,065 | 10,360 | 11,655 | 12,950 | 14,245 | 15,540 | 16,835 | | | | | | | | | | | | | |
| 24 | | 6,142 | 7,371 | 8,589 | 9,828 | 11,056 | 12,284 | 13,513 | 14,742 | 15,970 | | | | | | | | | | | | | |
| 25 | | | 7,035 | 8,207 | 9,380 | 10,552 | 11,725 | 12,897 | 14 070 | 15,242 | | | | | | | | | | | | | |
| 26 | | | | 7,815 | 8,932 | 10,048 | 11,165 | 12,281 | 13,398 | 14.514 | 15,630 | | | | | | | | | | | | |
| 27 | | | | | 8,568 | 9,639 | 10,710 | 11,781 | 12,852 | 13,923 | 14,994 | 16,065 | | | | | | | | | | | |
| 28 | | | | | | 9,229 | 10.255 | 11,280 | 12,306 | 13,331 | 14,357 | 15,382 | | | | | | | | | | | |
| 29 | | | | | | 8,851 | 9,835 | 10,818 | 11,802 | 12,785 | 13,769 | 14,752 | 15,736 | | | | | | | | | | |
| 30 | | | | | | | 9,450 | 10,395 | 11,340 | 12,285 | 13,230 | 14,175 | 15,120 | | | | | | | | | | |
| 31 | | | | | | | 9,100 | 10,010 | 10,920 | 11,830 | 12,740 | 13,650 | 14,560 | 15,470 | | | | | | | | | |
| 32 | | | | | | | 8,785 | 9,663 | 10,512 | 11,420 | 12,299 | 13,177 | 14,056 | 14,934 | 15,813 | | | | | | | | |
| 33 | | | | | | | 8,470 | 9,317 | 10,164 | 11,011 | 11.858 | 12,705 | 13,552 | 14,399 | 15,246 | 16,093 | | | | | | | |
| 34 | | | | | | | 8 190 | 9,009 | 9,828 | 10,647 | 11,466 | 12,285 | 13,104 | 13,923 | 14,742 | 15,561 | 16,380 | | | | | | |
| 35 | | | | | | | 7,945 | 8,739 | 9,534 | 10,328 | 11,123 | 11,917 | 12,712 | 13,506 | 14,301 | 15,095 | 15,890 | 16,681 | | | | | |
| 36 | | | | | | | 7,700 | 8,470 | 9,240 | 10.010 | 10,780 | 11,550 | 12,320 | 13,090 | 13,860 | 14,630 | 15.400 | 16,170 | 16,940 | | | | |
| 37 | | | | | | | | 8,200 | 8,946 | 9,691 | 10,437 | 11,182 | 11,928 | 12,673 | 13,419 | 14,164 | 14,910 | 15,665 | 16,401 | 17,146 | | | |
| 38 | | | | | | | | 7,969 | 8,694 | 9,418 | 10,143 | 10,867 | 11,592 | 12 316 | 13,041 | 13,765 | 14,490 | 15,214 | 15,939 | 16,663 | 17,388 | | |
| 39 | | | | | | | | 7,738 | 8,442 | 9,145 | 9,849 | 10,552 | 11,256 | 11,959 | 12,663 | 13,366 | 14,070 | 14,773 | 15,477 | 16,180 | 16,884 | 17,587 | |
| 40 | | | | | | | | 7,507 | 8,190 | 8,872 | 9,555 | 10,237 | 10,920 | 11,602 | 12,285 | 12,967 | 13,650 | 14,332 | 15,015 | 15,697 | 16,380 | 17,062 | 17,745 |
| 41 | | | | | | | | 7,315 | 7,980 | 8,645 | 9,310 | 9,975 | 10,640 | 11,305 | 11,970 | 12,635 | 13,300 | 13,965 | 14,630 | 15,295 | 15,960 | 16,625 | 17,290 |
| 42 | | | | | | | | 7,122 | 7,770 | 8,417 | 9,065 | 9,712 | 10,360 | 11,007 | 11,655 | 12,302 | 12,950 | 13,597 | 14,245 | 14,892 | 15,539 | 16,187 | 16,835 |
| 43 | | | | | | | | | 7,560 | 8,190 | 8,820 | 9,450 | 10,080 | 10,710 | 11,340 | 11,970 | 12,600 | 13,230 | 13,860 | 14,490 | 15,120 | 15,750 | 16,380 |
| 44 | | | | | | | | | 7,392 | 8 008 | 8,624 | 9,240 | 9,856 | 10,472 | 11,088 | 11,704 | 12,320 | 12,936 | 13,552 | 14,168 | 14,784 | 15,400 | 16,016 |
| 45 | | | | | | | | | 7,182 | 7,780 | 8,379 | 8,977 | 9,576 | 10,174 | 10,773 | 11,371 | 11,970 | 12,568 | 13,167 | 13,765 | 14,364 | 14,962 | 15,561 |
| 46 | | | | | | | | | 7,014 | 7,598 | 8,183 | 8,767 | 9,352 | 9,936 | 10,521 | 11,105 | 11,690 | 12,274 | 12,859 | 13,443 | 14,028 | 14,612 | 15,197 |
| 47 | | | | | | | | | | 7,462 | 8,036 | 8,610 | 9,184 | 9,758 | 10,332 | 10,906 | 11,480 | 12,054 | 12,628 | 13 202 | 13,776 | 14,350 | 14,924 |
| 48 | | | | | | | | | | 7,280 | 7,840 | 8,400 | 8,960 | 9,520 | 10,080 | 10,640 | 11,200 | 11,760 | 12,320 | 12,880 | 13,440 | 14,000 | 14,560 |
| 49 | | | | | | | | | | 7,098 | 7,644 | 8,190 | 8,736 | 9,282 | 9,828 | 10,374 | 10,920 | 11,466 | 12,012 | 12,558 | 13,104 | 13,650 | 14,196 |
| 50 | | | | | | | | | | 6,961 | 7,497 | 8,032 | 8,568 | 9,103 | 9,639 | 10,174 | 10,710 | 11,245 | 11,781 | 12,316 | 12,852 | 13,387 | 13,923 |

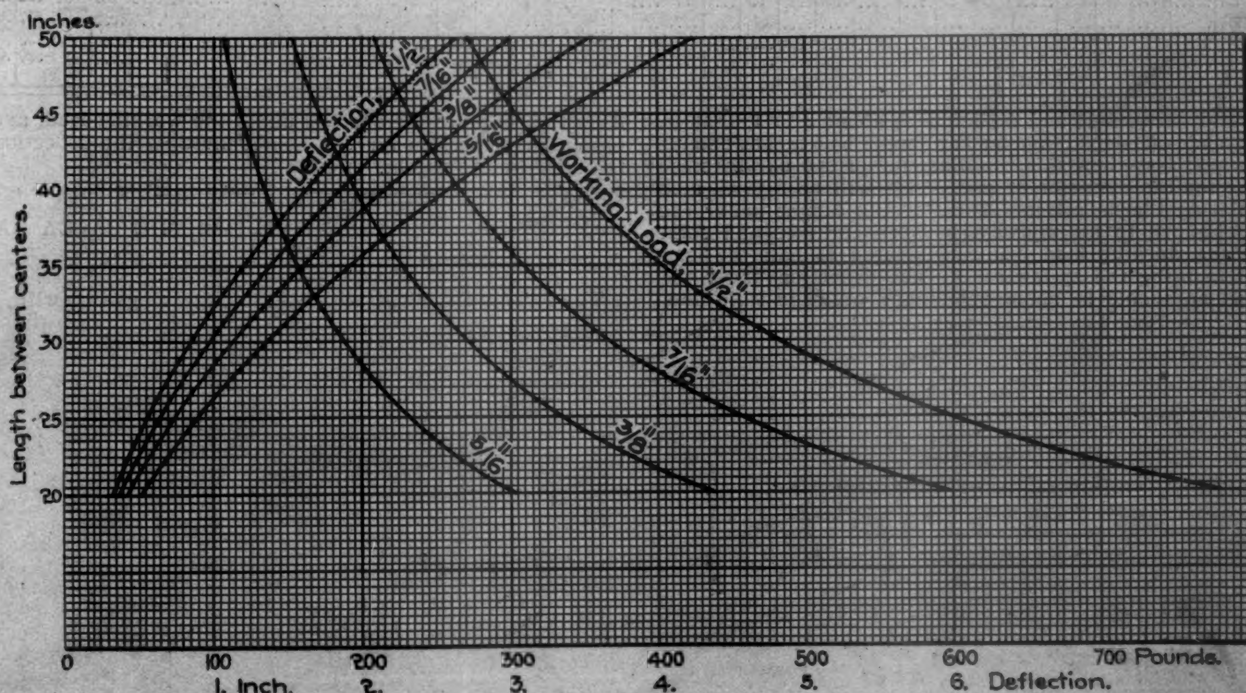



**Diagram of Working Loads and Deflections for Half Elliptic Springs.**

Plates 5/16 to ½ inch thick and 1 inch wide, bands 4 inches wide. Example: Required the working load and deflection of a spring 40 inches long, 4 inches wide, having 15 plates ⅜ inch thick.

Follow the horizontal line 40 to its intersection with the curved line marked "working load, ⅜ inch," then vertically to the base line, and read off 195 pounds. Then 195 × 4 × 15 = 11,700 pounds working load. Similarly for the deflection, to the curved line marked "deflection ⅜ inch" and then to the base line and read off 2.15 inches, the amount the spring will deflect from the free to the loaded height, which amount is independent of the width and number of plates.

For full elliptic springs the deflection is twice that given in the table; the limit would be reached at 25 inches for ⅜-inch steel, and at 23 inches for 5-16-inch steel.

For passenger engines 2 inches deflection would give better results. Where the conditions will allow a long spring to be used, its durability would be much increased by making the plates 5, or even 6 inches in width, decreasing the stress to 60,000 pounds per square inch, and increasing the thickness to 7-16, or ½ inch, but maintaining the desired deflection. The use of driving springs over 3½ inches wide is in most cases restricted to those below the driving boxes, known as "underhung."

In calculating the working loads and deflections for helical springs made of solid circular bars, the formulæ generally used are as follows:

Let P = working load carried by spring = one-half the load when solid.

d = diameter of steel bar.

R = radius to center of coil.

D = deflection of spring under working load.

G = modulus of shearing elasticity, assumed to be 13,000,000 pounds.

L = length of bar before coiling.

S = working shearing fibre strain in bar, 40,000 to 50,000 pounds.

M = number of coils.

$H_s$ = height when solid.

H = height when free.

$\pi = 3.1416$.

T = tapered length of bar.

Then $P = \frac{S \pi d^3}{16 R}$ $L = \frac{2 \pi R H_s}{d}$ $M = \frac{L}{\pi 2 R}$

$M = \frac{H_s}{d}$ $L = M 2 \pi R$ $T = \frac{\pi 2 R}{2} + L$

$D = \frac{2 R S L}{d G}$ $D = \frac{H}{8}$

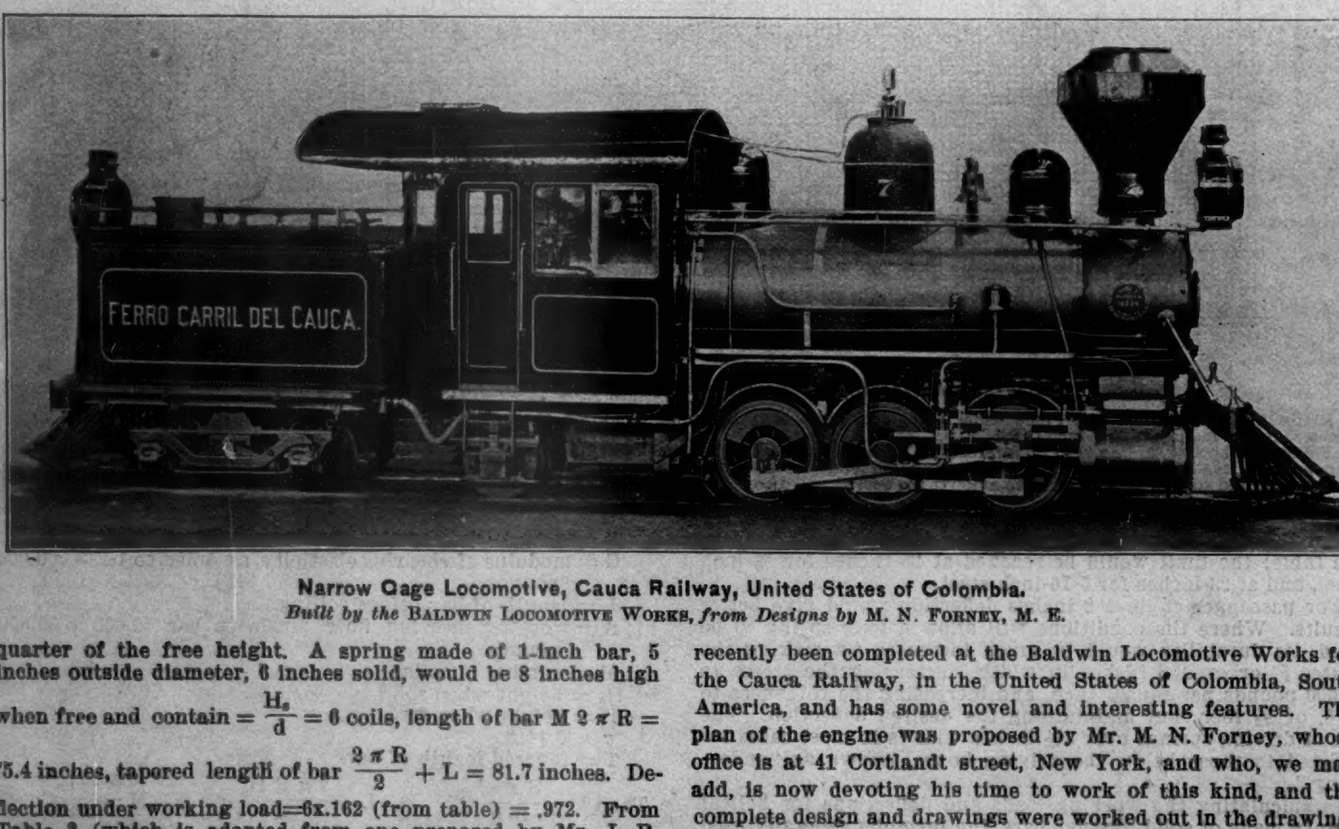
TABLE No. 3.

Working Loads and Deflections for Helical Springs.

$$P = \frac{S \pi d^3}{16R} \qquad D = \frac{2RSL}{dG}$$

| Outside Dia. | 40,000 lbs. 1⅜" Dia. | | 40,000 lbs. 1 5/16" Dia. | | 40,000 lbs. 1¼" Dia. | | 40,000 lbs. 1 3/16" Dia. | | 40,000 lbs. 1⅛" Dia. | | 41,000 lbs. 1 1/16" Dia. | | 42,000 lbs. 1" Dia. | | 42,000 lbs. 15/16" Dia. | | 43,000 lbs. ⅞" Dia. | | 44,000 lbs. 13/16" Dia. | | 44,000 lbs. ¾" Dia. | | 45,000 lbs. 11/16" Dia. | | 47,000 lbs. ⅝" Dia. | | 48,000 lbs. 9/16" Dia. | | 49,000 lbs. ½" Dia. | | 50,000 lbs. 7/16" Dia. | | 50,000 lbs. ⅜" Dia. | | Outside Dia. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Load | Def. | Load | Def. | Load | Def. | Load | Def. | Load | Def. | Load | Def. | Load | Def. | Load | Def. | Load | Def. | Load | Def. | Load | Def | Load | Def | Load | Def. | Load | Def. | Load | Def. | Load | Def. | Load | Def. | |
| 7" | 7260 | .222 | 6215 | .238 | 5336 | .256 | 4525 | .275 | 3902 | .304 | 3253 | .329 | 2749 | .365 | 2242 | .397 | 1847 | .445 | | | | | | | | | | | | | | | | | 7" |
| 6¾ | 7597 | .203 | 6532 | .218 | 5578 | .234 | 4729 | .252 | 4076 | .279 | 3396 | .302 | 2868 | .335 | 2338 | .365 | 1925 | 409 | | | | | | | | | | | | | | | | | 6¾ |
| 6½ | 7969 | .184 | 6847 | .196 | 5844 | .213 | 4951 | .230 | 4265 | .254 | 3552 | .276 | 2990 | .306 | 2444 | .334 | 2011 | .375 | 1630 | .422 | | | | | | | | | | | | | | | 6½ |
| 6¼ | 8376 | .167 | 7194 | 179 | 6136 | .193 | 5196 | .209 | 4474 | 231 | 3723 | .251 | 3142 | .279 | 2558 | .304 | 2104 | .343 | 1704 | .386 | 1355 | .438 | | | | | | | | | | | | | 6¼ |
| 6 | | | 7576 | .161 | 6459 | 174 | 5466 | .188 | 4703 | 209 | 3991 | .228 | 3299 | .253 | 2685 | .276 | 2207 | .311 | 1789 | .351 | 1420 | .399 | 1105 | .456 | | | | | | | | | | | 6 |
| 5¾ | | | | | 6818 | .156 | 5765 | .169 | 4957 | .188 | 4120 | .205 | 3472 | .229 | 2824 | .250 | 2320 | .282 | 1877 | .318 | 1491 | .362 | 1160 | .414 | 879.3 | .477 | | | | | | | | | 5¾ |
| 5½ | | | | | | | 6090 | .151 | 5240 | .169 | 4352 | .184 | 3665 | .205 | 2979 | .224 | 2445 | .253 | 1977 | .287 | 1569 | .327 | 1220 | .374 | 924.3 | .432 | 679 | .502 | | | | | | | 5½ |
| 5¼ | | | | | | | 6475 | .134 | 5558 | .149 | 4612 | .164 | 3881 | .183 | 3152 | .201 | 2585 | .227 | 2089 | .257 | 1657 | .293 | 1287 | 336 | 974.2 | .388 | 716 | .453 | | | | | | | 5¼ |
| 5 | | | | | | | | | 5916 | .132 | 4905 | .144 | 4123 | .162 | 3346 | .178 | 2742 | .202 | 2213 | .229 | 1754 | .262 | 1361 | .301 | 1030 | .348 | 756 | .406 | 534 | .480 | | | | | 5 |
| 4¾ | | | | | | | | | | | 5237 | .126 | 4398 | .142 | 3565 | .157 | 2919 | .178 | 2354 | .203 | 1864 | .232 | 1445 | .267 | 1093 | .309 | 801 | .361 | 566 | .428 | | | | | 4¾ |
| 4½ | | | | | | | | | | | | | 4712 | .124 | 3815 | .137 | 3120 | .156 | 2513 | .178 | 1988 | .204 | 1540 | .235 | 1163 | .273 | 852 | .319 | 601 | .379 | 405 | .456 | | | 4½ |
| 4¼ | | | | | | | | | | | | | | | 4103 | .118 | 3352 | .135 | 2694 | .155 | 2130 | .178 | 1648 | .205 | 1243 | .239 | 910 | .280 | 641 | .333 | 431 | .401 | | | 4¼ |
| 4 | | | | | | | | | | | | | | | | | 3620 | .116 | 2908 | .133 | 2294 | .153 | 1772 | .177 | 1335 | .207 | 976 | .244 | 687 | .290 | 461 | .350 | 286 | .423 | 4 |
| 3¾ | | | | | | | | | | | | | | | | | 3934 | .098 | 3155 | .113 | 2485 | .131 | 1917 | .152 | 1442 | .177 | 1087 | .197 | 740 | .250 | 496 | 303 | 307 | .367 | 3¾ |
| 3½ | | | | | | | | | | | | | | | | | | | 3449 | .094 | 2711 | .109 | 2087 | .128 | 1567 | .150 | 1142 | .178 | 802 | .213 | 537 | .259 | 331 | .315 | 3½ |
| 3¼ | | | | | | | | | | | | | | | | | | | | | 2982 | .090 | 2291 | .106 | 1716 | .125 | 1248 | .111 | 875 | .179 | 585 | .219 | 360 | .267 | 3¼ |
| 3 | | | | | | | | | | | | | | | | | | | | | | | 2539 | .086 | 1897 | .102 | 1376 | .123 | 962 | .148 | 642 | 181 | 394 | .222 | 3 |
| 2¾ | | | | | | | | | | | | | | | | | | | | | | | | | 2120 | .082 | 1533 | .098 | 1069 | .120 | 711 | .148 | 336 | .182 | 2¾ |
| 2½ | | | | | | | | | | | | | | | | | | | | | | | | | | | 1751 | .077 | 1202 | .094 | 797 | .118 | 487 | .146 | 2½ |
| 2¼ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1374 | .072 | 907 | .091 | 552 | .113 | 2¼ |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1052 | .067 | 637 | .085 | 2 |
| 1¾ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 753 | .061 | 1¾ |
| 1½ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 920 | .041 | 1½ |

The ratio between R and d should be about 2 to 1, that is, a spring made of 1-inch diameter bar should be 5 inches outside diameter. If less than this the diameter of the bar becomes too great for the diameter of coil. This will be noticed also in calculating the deflection. The working height under the load is assumed to be midway between the free and solid heights, the working load being considered as half the load required to bring the spring solid. The deflection under the working load should be about one-eighth, or when solid one-



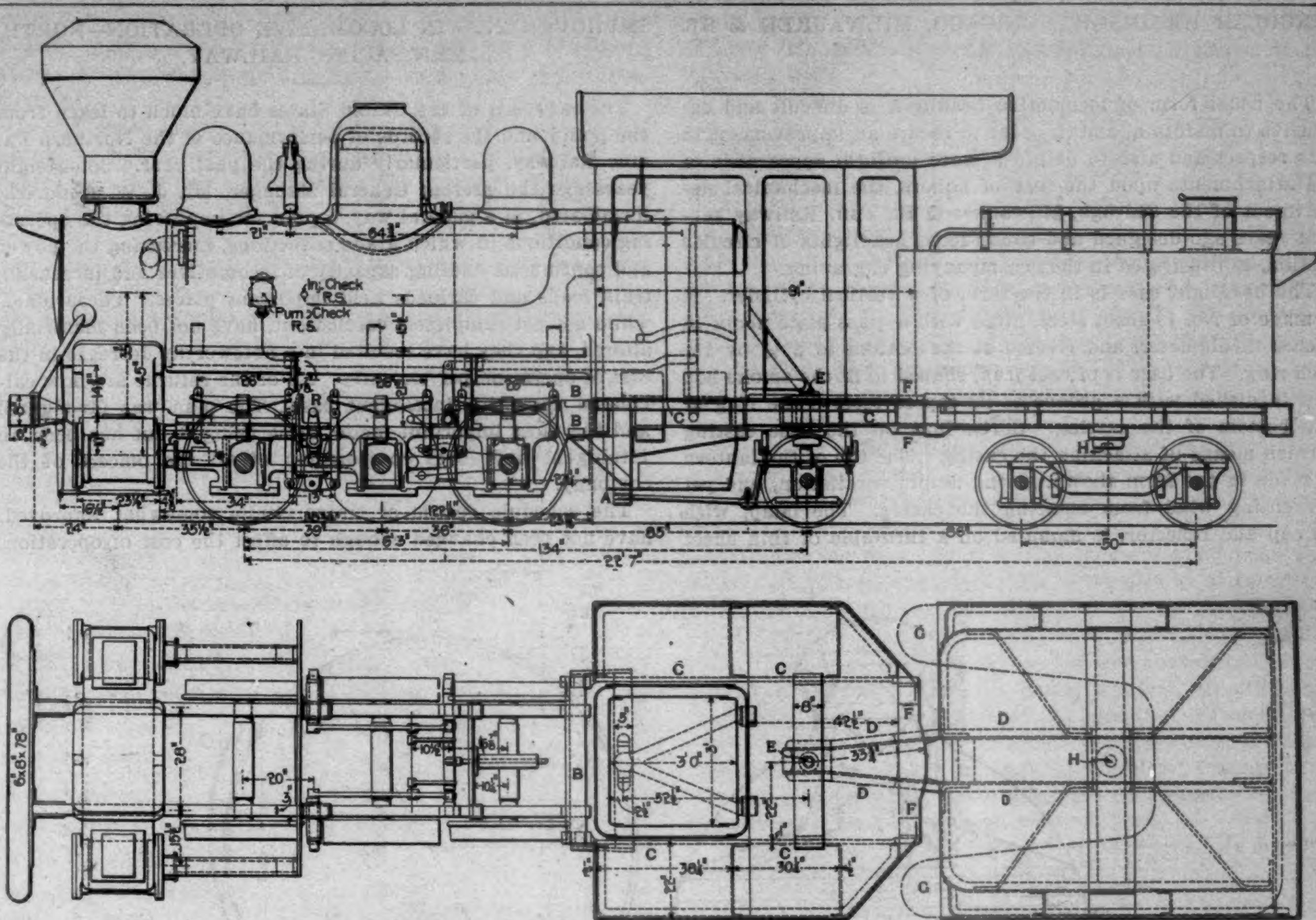

**Narrow Gage Locomotive, Cauca Railway, United States of Colombia.**
*Built by the* BALDWIN LOCOMOTIVE WORKS, *from Designs by* M. N. FORNEY, M. E.

quarter of the free height. A spring made of 1-inch bar, 5 inches outside diameter, 6 inches solid, would be 8 inches high when free and contain $= \frac{H_s}{d} = 6$ coils, length of bar $M\, 2\, \pi\, R = 75.4$ inches, tapered length of bar $\frac{2\, \pi\, R}{2} + L = 81.7$ inches. Deflection under working load=6x.162 (from table) = .972. From Table 3 (which is adapted from one prepared by Mr. J. R. Onderdonk) a spring of suitable strength, size of bar, outside diameter and deflection may be selected. The working load is of course independent of the height, it remaining constant whether the spring is one or any number of coils high. The deflection is given for one coil under the working load, and to obtain the deflection for any height multiply the deflection in the table by the number of coils.

## NARROW-GAUGE LOCOMOTIVE FOR THE CAUCA RAILWAY.

The locomotive illustrated by the engravings herewith, has recently been completed at the Baldwin Locomotive Works for the Cauca Railway, in the United States of Colombia, South America, and has some novel and interesting features. The plan of the engine was proposed by Mr. M. N. Forney, whose office is at 41 Cortlandt street, New York, and who, we may add, is now devoting his time to work of this kind, and the complete design and drawings were worked out in the drawing-room of the Baldwin Works.

The conditions to be fulfilled were exacting and somewhat peculiar. The road is of 3-foot gauge, with curves of a minimum radius of 200 feet, and therefore it was stipulated that



**Narrow Quage Locomotive, Cauca Railway, United States of Colombia.**
*Built by the* BALDWIN LOCOMOTIVE WORKS, *from Designs by* M. N. FORNEY, M. E.

the wheel-base measured from the centre of the front driving-axle to that of the trailing truck must not exceed 16 feet. It was thought that a shorter wheel-base would be desirable. The rails on the road weigh 30 and 40 pounds per yard. There are no turntables on the line, so the locomotive must run both ways. The requirements of the traffic demanded adhesive weight of 42,000 pounds on the driving-wheels, which, owing to the lightness of the rails, had to be distributed on three pairs of wheels, and it was considered essential that this weight should be uniform, and therefore no part of the water or fuel could be carried on them. It was also stipulated that the tank should carry 1,000 gallons of water, with a sufficient supply—about a cord—of wood for fuel. The first intention was to carry these on a four-wheeled trailing truck, thus making the engine of what has come to be known as the "Forney" type.

The difficulty was encountered of getting room enough for the fuel and water if they were carried on such a truck, without lengthening the wheel-base too much, for the short curves on which the engine must run. The difficulty will be apparent if it is observed that a space of about 4½ feet should be provided behind the boiler for the engineer and fireman to work in, and a tank of the capacity required must be about eight or nine feet long. If this was supported on a four-wheeled trailing truck, the latter must be located so far back as to lengthen the wheel-base too much. It was therefore determined to place a pony-truck below the footboard, as shown in the engravings. This truck consists of the usual A-shaped frame, pivoted to a center pin at A, Fig. 2. The driving-wheels were grouped together as closely as possible, to leave room for the rocking-shaft at R, and were located between the fire-box and smoke-box—their wheel-base being only 6 feet 3 inches. This arrangement permitted the fire-box to be made as wide as the distance over the outside of the tires, and it might have been made still wider had it been thought desirable to do so. Two strong bars or braces, B B, were bolted to the back ends of the main frames and extended outward beyond the outside of the fire-box, and slab frames, C C, were attached to their outer ends and extended backward on each side of the fire-box, and supported the footboard and cab. By locating the single pair of truck wheels below the footboard they could be brought up near the fire-box, so that the total wheel-base of the engine was only 13 feet 4 inches. The tank was then placed on a separate frame made of channel bars, the two middle ones of which, D D, were extended forward under the footboard and were attached to a center pin, E, directly over the pony-truck axle. A four-wheeled side-bearing truck of an ordinary form of construction was then placed below the tender frame, to carry the tank. To the back ends of the slab-frames two bars, F F, were fastened, and the extended channel bars, D D, passed between them, and had sufficient play so as to permit of any vertical movement of the engine and tender in relation to each other, due to inequalities of the road. The tender frame, of course, turns about the centre pin E. For this reason the back end of the cab was made octagonal in form, as shown in the plan, Fig. 3, so that the front ends or legs of the tank may turn about the pin E, without coming in contact with the cab. As the four-wheeled tender truck can turn freely about its own center-pin at H, and the tender frame can turn about the pin E, and also rise and fall in relation to the engine, it will be seen that the engine has the utmost flexibility and capacity of adaptation to vertical and horizontal inequalities of the road. Nearly the whole weight of the engine is utilized for adhesion; a large roomy cab is provided with ample space behind the fire-box and transversely on the footboard. On narrow gauge engines this space is often very much contracted. The grate is 3 by 3 feet, which was considered ample, but could have been made larger had it been considered desirable to do so.

While the design was under consideration the question was asked why not use a simple four-wheeled tender instead of the arrangement which was adopted. The objection to a four-wheeled tender would be that it would be very unsteady, especially when running backward, whereas with the plan shown the tender frame is supported at E, and also on the centre of the four-wheeled truck, so that vertical steadiness is secured, with perfect lateral flexibility.

The general plan, it is thought, could with much advantage be applied to larger locomotives of any gauge.

The following are the principal dimensions of this engine:

Cylinders, 12 by 16 inches.

Driving-wheels, 33 inches diameter.

Weight of engine, about 46,000 pounds; weight of tender, about 17,000 pounds.

Waist of boiler, 40 inches diameter; tubes, 1¾ inches diameter and 9 foot 6 inches length.

Fire-box, 36 by 36 inches inside.

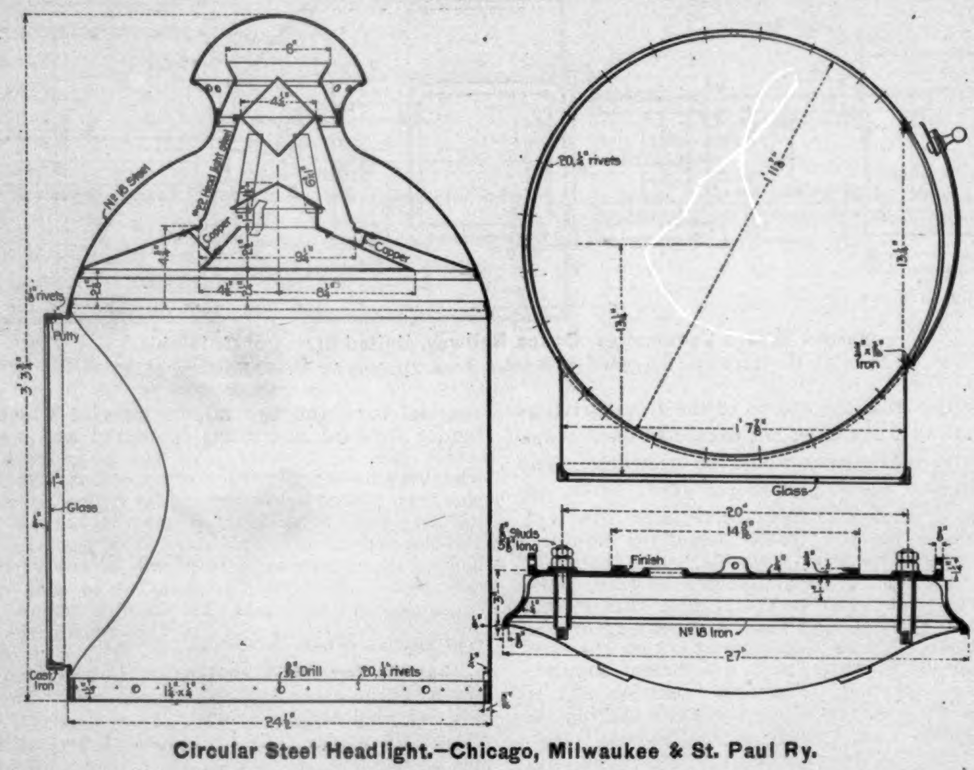
Truck wheels, 24 inches diameter.

## CIRCULAR HEADLIGHT, CHICAGO, MILWAUKEE & ST. PAUL RY.

The usual form of locomotive headlight is difficult and expensive to maintain, and in order to secure an improvement in this respect and also to obtain a more uniform appearance of the attachments upon the tops of boilers, the mechanical department of the Chicago, Milwaukee & St. Paul Railway several years ago designed and constructed headlights of circular section, as illustrated in the accompanying engraving.

The headlight case is in the form of a vertical cylinder. It is made of No. 18 sheet steel, fitted with a glass plate about 18 inches in diameter, and riveted at the bottom to a ¼ by 1¼ inch ring. The base is of cast iron, shaped to fit the smoke box and furnished with a groove at its top to receive the ring at the bottom of the casting. Seven lugs on the base casting furnish means of attaching the casing. The top of the lantern is made in the form shown, giving ample ventilation, and yet preventing wind from entering the casing. The lamp, with oil cup and reflector, is mounted on a turntable of thin sheet steel, which is carried on a dished plate of steel 1-16 inch thick, that is slid into grooves cast in the headlight base. The casing has a door about 13 inches wide on the left side, giving easy access to the lamp. Air is admitted through an elliptical hole in the base casting, which is covered by a strainer attached to the lamp base and so located as to register with the hole in the casting when the lamp and reflector are turned into position. The amount of air admitted may be adjusted by a slide. The open space under the cast iron base is packed with asbestos.

The cost of this headlight is about three dollars more than one of the ordinary form complete, including the lamp platform and brackets, but inasmuch as one of the latter will sometimes require complete overhauling after less than two years' service, and since the circular form is an admirable one for strength and durability, a material saving is expected. Aside from this, the appearance of the circular headlight is neat and attractive. Used in connection with a dome and sand box, which are of helmet form, it is in good taste and gives a uniform and tasteful look to an engine.




Circular Steel Headlight.—Chicago, Milwaukee & St. Paul Ry.

## IMPROVEMENTS IN LOCOMOTIVE OPERATION—NORTHERN PACIFIC RAILWAY.

The railroads of the United States have much to learn from the policy and the records of performance of the Northern Pacific Railway, particularly during the past year. Some eight years ago the present General Manager, Mr. J. W. Kendrick, formulated, in a general way, a plan for improving the operating conditions in which grade reductions, increasing the power and continuous hauling capacity of locomotives and increasing train loads and carloads held important places. These plans, while not yet completely carried out, have not been materially altered, and they have resulted in a noteworthy decrease in the cost of operation per ton mile. All of the returns are now calculated upon this intelligent basis. The plan was far-sighted and the most important factor in carrying it out has been an intelligent and loyal co-operation of all the officers of the company.

The schedule speeds of trains, while somewhat improved, have not been changed enough to affect the cost of operation, but the weight of trains and the distances covered by the locomotives have been greatly increased. The two most important factors are reductions of grades and increased power of locomotives, as contributive to the latter, the assignment of the engines to the various divisions has been entirely revised and arranged with a view of using each engine where it will operate most favorably. The cutting down of grades was done very gradually, at first starting on the east end of the line where the traffic was heaviest, and extending to the heavier work when conditions warranted. The ultimate object is to haul about 1,200 tons per train from St. Paul to the Rocky Mountains without breaking the trains. This not only means effective and economical operation of locomotives, but incidental advantages are gained by saving delays and expenses due to switching trains about on the way. The length of locomotive runs has also been greatly increased, and they are now run through instead of changing at the terminals of districts, and the result in passenger service is to reduce the number of engines in service about 50 per cent., several of the less important district terminals having been abandoned altogether. The

freight engines have also been redistricted for the reasons given. Further advantage has been gained by the use of compounds.

In the use of compound locomotives this road has avoided a serious mistake that many have made by not designing the compounds to be powerful enough. The power of the engine is quite as important as the type, and this has not been generally recognized. This fact accounts for a great deal of the apathy and even doubt which is seen in the estimate of the value of the compound feature. The Northern Pacific records are convincing as to the advantages of the type, and all new freight engines now building are to be compounds.

The following table taken from the annual report of the general manager shows the engine ratings upon the various divisions prior to 1893, in 1897 and 1898, and also the intended future rating. These remarkable figures result from a combination of the factors previously mentioned and they constitute an example which is worthy of the most careful study, contributing as they do to operating the road for 46.9 per cent. of the gross earnings:

Comparison of Train Tonnage.

E=Eastbound. W=Westbound.

| Division and District. | | Tonnage. Prior to 1893. | | 1897. | | 1898. | | Future. |
|---|---|---|---|---|---|---|---|---|
| Lake Superior, Second | | 650 | E | 1,350 | E | 1,350 | E | 1,350 |
| | | | W | 1,350 | W | 1,350 | W | 1,350 |
| Minnesota, Second | | 700 | E | 1,350 | E | 1,500 | E | 1,500 |
| | | | W | 1,400 | W | 1,500 | W | 1,500 |
| Manitoba, First | | 800 | E | 1,050 | E | 1,500 | E | 1,500 |
| | | | W | 1,050 | W | 1,350 | W | 1,500 |
| Dakota, First | | 840 | E | 1,350 | E | 1,350 | E | 1,350 |
| | | | W | 1,200 | W | 1,200 | W | 1,200 |
| Dakota, Second | | 700 | E | 1,000 | E | 1,000 | E | 1,350 |
| | | | W | 1,000 | W | 1,000 | W | 1,350 |
| Missouri, First | | 425 | E | 675 | E | 1,000 | E | 1,350 |
| | | | W | 675 | W | 925 | W | 1,350 |
| Missouri, Second | | 425 | E | 715 | E | 875 | E | 1,350 |
| | | | W | 750 | W | 875 | W | 1,350 |
| Yellowstone, First | | 625 | E | 1,200 | E | 1,250 | E | 1,500 |
| | | | W | 850 | W | 875 | W | 1,350 |
| Yellowstone, Second | | 625 | E | 1,200 | E | 1,250 | E | 1,500 |
| | | | W | 850 | W | 875 | W | 1,350 |
| Montana, First | E | 1,000 | E | 1,500 | E | 1,500 | E | 1,500 |
| | W | 650 | W | 1,000 | W | 1,000 | W | 1,000 |
| Montana, second | E | 375 | E | 1,000 | E | 1,000 | E | 1,200 |
| | W | 750 | W | 1,000 | W | 1,000 | W | 1,000 |
| Rocky Mountain, First | E | 400 | E | 1,000 | E | 1,200 | E | 1,200 |
| | W | 375 | W | 1,050 | W | 1,050 | W | 1,200 |
| Rocky Mountain, Second | E | 400 | E | 840 | E | 1,000 | E | 1,200 |
| | W | 400 | W | 900 | W | 950 | W | 1,200 |
| Idaho, First | E | 450 | E | 1,000 | E | 1,065 | E | 1,200 |
| | W | 450 | W | 1,000 | W | 1,065 | W | 1,065 |
| Idaho, Second | E | 525 | E | 900 | E | 900 | E | 1,200 |
| | W | 640 | W | 875 | W | 900 | W | 1,200 |
| Idaho, Third | E | 650 | E | 1,500 | E | 1,500 | E | 1,500 |
| | W | 500 | W | 820 | W | 1,125 | W | 1,200 |
| Pacific, Ellensburg to Easton | | 594 | E | 900 | E | 900 | E | 1,000 |
| " Easton to Lester | | 810 | W | 900 | W | 1,225 | W | 1,225 |
| " Lester to Tacoma | E | 406 | | | | | | |
| | W | 810 | | | | | | |
| Pacific, Second | E | 535 | E | 620 | E | 1,100 | E | 1,100 |
| | W | 525 | W | 620 | W | 1,100 | W | 1,100 |

During the month of September last the average tonnage in one direction on the first of these divisions was 1,577 tons per train for the 30 days.

The locomotive equipment has been increased in power, notwithstanding the fact that the actual number of engines in use has decreased. This is due to the purchase of the following new and powerful engines:

| Number. | Type. | Weight on drivers. | Total weight. |
|---|---|---|---|
| 18 | 10 wheel | 112,000 lbs. | 155,500 lbs. |
| 18 | 10-wheel | 126,000 lbs. | 172,500 lbs. |
| 7 | 10-wheel | 131,800 lbs. | 173,800 lbs. |

The increase in train weights for two periods of six months each is as follows:

| | Gross tons per engine mile. 1897. | 1898. | Inc., pr. ct. | Gross tons per train mile. 1897. | 1898. | Inc., pr.ct. |
|---|---|---|---|---|---|---|
| January | 392 | 474 | 20.92 | 600 | 679 | 13.16 |
| February | 401 | 497 | 23.94 | 619 | 710 | 14.70 |
| March | 430 | 508 | 18.14 | 643 | 716 | 11.35 |
| April | 453 | 521 | 15.00 | 601 | 727 | 20.96 |
| May | 470 | 528 | 11.00 | 615 | 724 | 17.70 |
| June | 478 | 521 | 9.00 | 629 | 698 | 11.00 |

Twelve engines were purchased from the Montana Union Railway and 95 light, 17 by 24 inch, eight wheel engines were retired. With the addition of 55 engines, the total decrease during the year was 40, leaving a total of 542 on the list. The effect of this on the power of the equipment is shown in the following table:

| | June 30, 1897. | June 30, 1898. | Inc. or Dec. | | Inc. or Dec. | |
|---|---|---|---|---|---|---|
| Number of engines | 583 | 542 | D. | 40 | D. | 6.9% |
| Weight on drivers | 42,767,565 | 44,432,965 | I. | 1,665,400 | I. | 3.89% |
| Total weight | 55,718,770 | 56,616,520 | I. | 897,750 | I. | 1.61% |
| Number of road engines | 505 | 460 | D. | 45 | D. | 8.9% |
| Total horse power | 249,275 | 263,625 | I. | 14,350 | I. | 5.8% |

This horse power was taken from indicator cards and represents that which the engines develop in continuously sustained service. These figures, showing an increase of 5.8 per cent. of horse power, with a decrease of 8.9 per cent. in the number of engines, need no comment, except the remark that perhaps it will be found that the stresses on the 56 and 72 pound rails used as standards on the road may show them to be too light for the service required.

Among the other improvements included in the general scheme are new designs of coaling stations, with bins holding 35 tons of coal, which is weighed for the engine records by the ingenious dynamometer devised by Mr. E. H. McHenry, Chief Engineer of the road. In these the bins are hung upon rods inclined at such an angle from the perpendicular as to cause a thrust of one-tenth of the weight against the dynamometer. The weight is indicated by a gauge which is in sight of the fireman, who can tell the exact amount of coal chuted into the engine tank. Water stations have also received attention, and the reinforcement of old cars to increase their capacity from 40,000 to 50,000 lbs., has been applied to 5,586 cars, giving an increase of 55,860,000 lbs. in carrying capacity. The attendant increase in weight of a car is about 200 lbs., and the improvement is equivalent to 930 new 60,000 lb. cars.

In making these changes a liberal, far-sighted policy is kept in mind, and in many ways the expenditures of a number of years are made to contribute now to the decrease in the cost of operating the road. The method of keeping the records is admirable, the tonnage basis being used throughout even for oil and waste. The monthly records on the entire road are distributed among the operating officers and each is enabled to keep very close watch of the expense of the work under his charge. The necessity for knowing the cost is fully appreciated and the information appears to be used co-operatively for improvement.

## THE U. S. REPAIR SHIP "VULCAN."

In the annual report of Commodore Melville, Chief of the Bureau of Steam Engineering of the United States Navy, the following statement is made in regard to the value of repair ships:

In the last report attention was called to the desirability of making such preparation for the fitting out of a vessel which would be a floating repair shop as would enable the work to be done with great rapidity when needed. Immediately on the prospect of war the bureau again brought this matter to the Department's attention, and the steamer Chatham was bought, set aside for this purpose and renamed the Vulcan. The work of installing the machine tools, cupola, forges, brass furnaces, etc., was pushed as rapidly as possible, as well as the selection of a force of skilled mechanics. A large and well chosen outfit of stores of all kinds was also supplied.

The Vulcan arrived at Guantanamo on July 1 and proved of the highest usefulness to the fleet, making repairs of all kinds and furnishing much needed supplies to every department of nearly every vessel. At the end of August reports from her officers showed that she had made repairs to sixty-three ships and had supplied stores to sixty. Her unusual facilities and the large number of skilled mechanics on board (about 100) enabled her to make repairs of all kinds, including hull work, gun mounts, dynamos, main steam pipes, main piston rods (for small ships), brass castings without end, and iron castings in considerable quantity. This last is specially interesting as the first instance of the successful use of a cupola on shipboard.

The steam turbine is being watched carefully by the Bureau of Steam Engineering of the navy, but, according to the latest report, it is not yet considered as an unqualified success.

## COMMUNICATIONS.

### GRATE AREAS, HEATING SURFACES AND CYLINDER VOLUMES.

Editor "American Engineer:"

In your October issue there appeared a communication on this subject by Mr. C. M. Higginson, in which he establishes from his experience the ratios that should exist between the grate areas and cylinder volumes of locomotives for road service when western coals are used for fuel. This method of computing grate areas is often advocated, but it has always appeared to me as erroneous and misleading. With a given quality of fuel, the size of the grate needed is dependent upon the rate at which steam must be produced, regardless of whether that steam is used in an 18 or 28-inch cylinder. If the size of the cylinder were in all cases proportional to the steam consumption per minute when the engine is doing its maximum work, the required grate area would bear a fixed ratio to the cylinder volume; but, as the cylinder volume is not an exact indication of the steam consumption, a fixed ratio is, in my opinion, unquestionably wrong.

Mr. Higginson advocates a ratio of 2.4 square feet of grate per cubic foot of cylinder volume. For most road engines this is too small, particularly if the engines are for fast freight or passenger service. As showing the fallacy in a fixed ratio I would ask if any careful designer, be he railroad official or locomotive builder, would decide on a grate area for a 20"x24" locomotive without knowing anything more about the engine? Would anyone use a ratio of 2.4, which would only give 21 square feet of grate, without knowing something of what is expected of the engine? Is it not evident that if the engine is to haul heavy passenger trains at high speeds its grate area should be larger than if it is to be used in slow freight service?

The fact is that the ratio of 2.4 applies fairly well to many of the modern mammoth freight engines, such as the Pennsylvania Class H-4, the Great Northern engines, or the enormous consolidation engine for the Union Railway of Pittsburg, which you illustrated last month, for the reason that these engines do the work at very slow speeds; but the figure is not suitable for engines of moderate size intended for faster service. In the following table I give a few particulars of a number of engines. The engines are arranged approximately in the order of their size, the heaviest and slowest first, and the lightest, and presumably the fastest, is placed last:

| | Cylinders. Inches. | Diam. of Drivers. Inches. | Wt. on D'vers. Lbs. | Steam Press. | Grate Area. Sq. ft. | Heating. Surface. | Ratio Grate Area to Cyl. Volume. | Ratio Heating Surface to Grate area. |
|---|---|---|---|---|---|---|---|---|
| Union Ry. of Pittsburg... | 23x32 | 54 | 208,000 | 200 | 33.5 | 3,322 | 2.18 | 99 |
| Penna. Rd., Class H-4.. | 22x28 | .. | 173,400 | 180 | 29.7 | 2,470 | 2.41 | 83 |
| Gt. Nor. 10-whl. pass.. | 20x30 | 63 | 129,500 | 210 | 35.4 | 2,677 | 3.25 | 75 |
| Nor. Pac. 10-whl. pass.. | 20x26 | 60 | 112,000 | 200 | 30.8 | 2,485 | 3.26 | 81 |
| C. & N. W. 8-whl. pass.. | 19x24 | 75 | 79,000 | 190 | 26.8 | 1,910 | 3.40 | 71 |

Please note the increase in the ratio of the grate area to the cylinder volume as we go from the heavy freight engine to the passenger engines running in mountainous districts, and finally to the eight-wheeled passenger engine running in a locality where the grades are easier and the average speed consequently higher. Please note, also, the decrease in the ratios between heating surface and grate area as we go from heavy to lighter engines. Every foot of heating surface that could be obtained within the limits of weight, doubtless, was obtained in each case, but in the passenger engines the ratio could not be made as large as in the freight. In the mammoth freight engines large heating surfaces are obtainable, but large grates are not an actual necessity and the difficulty in firing them properly tends to keep them even smaller than Mr. Higginson's ratio would require; on the other hand, in high-speed passenger engines the greater consumption of steam per unit of cylinder volume per minute requires a larger grate than given by his ratio, even if a corresponding increase in heating surface is not possible within the weight available. I have an intimate knowledge of the performance of the engine that is last in the above table, and I have no hesitation in saying that if the ratio between grate area and cylinder volume in that engine was 2.4, instead of the 3.4 that it is, the engine would be a flat failure.

If another illustration is necessary to prove my position, I would state that on a western road ten 18 by 24-inch passenger engines with a grate area of exactly 2.4 times the cylinder volume have proved such poor steamers that new boilers with larger grates are being put in them. The heating surface was sufficient, but the grate area was not.

I wish to say in conclusion that in the desire to see large heating surfaces and moderate-size grates my views coincide with those of Mr. Higginson, and I disagree with him only in that I don't believe in his fixed ratio between grate areas and cylinder volumes.

W. H. MARSHALL.

Asst. Supt. Motive Power, Chicago & Northwestern Ry.

Chicago, Nov. 2, 1898.

### DANGEROUS LOCOMOTIVE CABS.

Editor "American Engineer:"

It is a lamentable fact that appalling disasters seem to be needed as final arguments to prove the menace to safety which lies in a continued disregard of palpable elements of danger.

The rear-end horror at Revere, Mass., on the evening of Aug. 26, 1871, on the Eastern Railroad of Massachusetts marked the degree of impressiveness required to force the adoption of the Westinghouse brake—a God-sent apparatus, which had already demonstrated its practicability and safety-enhancing capacity, and had long before been taken up by roads where congestion of traffic was an unknown quantity.

The finding some years ago on a New York ferryboat of a pilot dead at the wheel made it obligatory for the ferry companies to have a second person, usually a deck-hand, in the pilot house during each trip, an eminently proper measure. A close parallel in the finding of a slaughtered unfortunate on the footboard of a Philadelphia & Reading locomotive, perhaps three years ago, has not, however, so far as I have seen, resulted in means to set aside the evident risk attendant on such isolation of enginemen from firemen as is due to the employment of that type of engine known variously as "Hog," "Dirt Burner," "Mother Hubbard," etc., and more properly called the "Wootten" engine.

That an engineman can be stricken down and the fireman remain in ignorance of it for a dangerously long time cannot in honesty be denied by anyone who has covered a division on the firing deck of one of these engines during a dark and stormy night. In the comparatively inexpensive quality of fuel permitted by such grate surface as these engines have, there is no doubt in some localities a large advantage, but improvements are not always necessarily unalloyed blessings or successes. The main object intended may be accomplished, but when in so doing it seriously lessens the value of an important factor of safety, it can hardly be said to be a complete advancement.

In the engines so common twenty-five years back this source of danger, due to separation of crew, was lacking, and while it is fully recognized as having been only a happy chance that their cabs were designed on lines of greater sociability, it was still a chance, which furnished in a measure a dual control of the engine, and supplied a deficiency in that direction dangerously lacking in many of the modern monsters. In line with some of the first departures from that type of engine, which allowed mutual companionship and aid, was that style, rather undignifiedly referred to on the Erie road, in my hearing, as "Wilder's stem winders," where the firing was done wholly outside of the cab, though at a but slightly increased distance between the two men on the engine. Then, following a dangerous precedent of many years before, came the Wootten firebox engine, with its 15 feet of separation of engineman and fireman, and with it the introduction of a danger to be proven sooner or later by some convincing truth, other, it is hoped, rather than a catastrophe, not traceable to another cause.

Perhaps the latest tragic proof of the lurking presence of this threat against safety, which has just occurred on another prominent nearby road with this class of engine, will arouse sufficient attention to result in the minimizing, if not abolition, of this unnecessary risk.

Large bodies are usually richer in inertia than smaller ones, hence a possible explanation of why a safeguard against this particular danger was quickly put into use by ferry companies and apparently ignored by railroad companies. The tortoise has been guarded; the hare left unprotected.

WM. F. MONAGHAN, M. E.,
Member A. S. M. E.

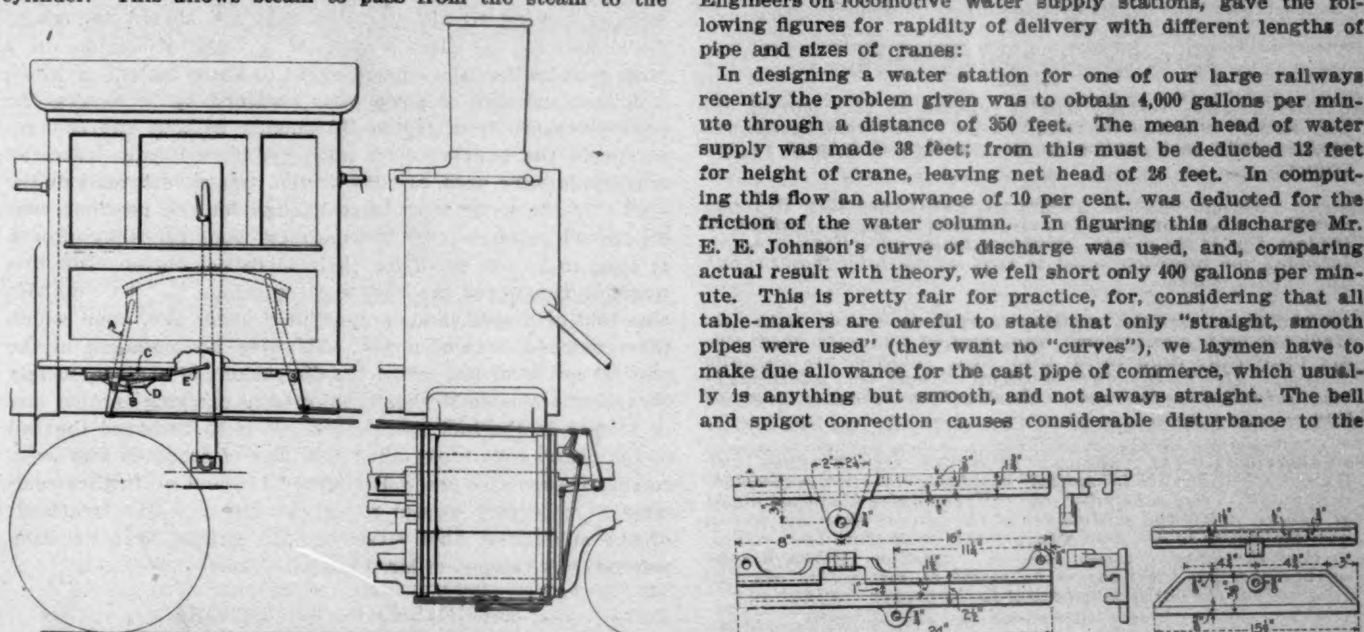
New York, November 21, 1898.

## STARTING VALVE LOCKING DEVICE FOR COMPOUND LOCOMOTIVES, PHILADELPHIA & READING RY.

The device shown in the accompanying illustrations is presented through the courtesy of Messrs. L. B. Paxon, Superintendent of Motive Power, and Mr. E. E. Davis, Assistant Superintendent of Motive Power, of the Philadelphia & Reading Railway. It was designed by Mr. H. H. Vaughan, Mechanical Engineer of the road. This road has a number of compound locomotives of the Vanclain type, and the purpose was to prevent the enginemen from working high-pressure steam in the low-pressure cylinders, except when the reverse lever is in full gear. This is accomplished by a simple arrangement which is applicable to any class of compounds on the road. It does not require the use of live steam in full gear unless the engineman moves a lever to operate the starting valve, and it automatically closes the valve as the reverse lever is moved out of full gear. It will be remembered that the device used on these compounds to increase the cylinder power in starting and in pulling over heavy grades consists of a by-pass connecting the two ends of the high-pressure cylinder. This allows steam to pass from the steam to the exhaust side of the high pressure piston and from there into the steam side of the low-pressure cylinder. The object of the attachment is to prevent improper use of the valve controlling this passage.

The arrangement of starting valve and cylinder cocks is shown in the drawing. The cylinder cocks are the regular ones in use on the road, and are screwed into bosses at each end of the high-pressure cylinder. The starting valve is a straightway plug cock fitted with a handle which, when shut, is in the position shown in the elevation, and is connected by a 1-inch pipe to the high-pressure steam ports. The cylinder cocks are actuated by the usual mechanism and are entirely separate from the valve, although the bell crank moving them works on the same pin as that for the valve, simply as a matter of convenience. The valve is worked by a lever, A, placed, in this case, behind the reverse lever. This lever has a short arm, to which a roller, B, is pinned, and is fulcrumed in the casting C, bolted to the running board. In this casting a slide, D, with inclined ends, is guided, which is connected by a rod, E, to a stud placed in the reverse lever at such a point that it travels 16 inches as the lever passes from "corner to corner." In the position shown the lever, A, is in the closed position and cannot be open on account of the roller, B, engaging with the slide, D. When the reverse lever is moved into full gear in either direction the slide travels far enough to clear the roller, and the combining valve can then be opened. If the reverse lever is then hooked up, the inclined end of the slide engages with the roller and forces the lever, A, back to the closed position. The slide is of such a length that the starting valve can be opened for about two notches in each end of the quadrant.

The device is well designed, and the general application of such a check upon the use of high-pressure steam would compel justice to compound locomotives and result in improved performance sheets. It is clear that for economical working this valve should be kept shut, except when actually needed to start the train or to prevent it from stalling. We are glad to be able to direct attention to improved methods of operating compound locomotives. This type, we believe, has suffered in many cases on account of lack of appreciation of the importance of observing the necessary precautions in using the compound principle at its best advantage.



**Starting Valve Locking Device for Compound Locomotives, Philadelphia & Reading Ry.**

## WATER STATIONS FOR RAPID DISCHARGE.

Mr. T. W. Snow, in a paper before the Western Society of Engineers on locomotive water supply stations, gave the following figures for rapidity of delivery with different lengths of pipe and sizes of cranes:

In designing a water station for one of our large railways recently the problem given was to obtain 4,000 gallons per minute through a distance of 350 feet. The mean head of water supply was made 38 feet; from this must be deducted 12 feet for height of crane, leaving net head of 26 feet. In computing this flow an allowance of 10 per cent. was deducted for the friction of the water column. In figuring this discharge Mr. E. E. Johnson's curve of discharge was used, and, comparing actual result with theory, we fell short only 400 gallons per minute. This is pretty fair for practice, for, considering that all table-makers are careful to state that only "straight, smooth pipes were used" (they want no "curves"), we laymen have to make due allowance for the cast pipe of commerce, which usually is anything but smooth, and not always straight. The bell and spigot connection causes considerable disturbance to the flow, setting up what in electrical parlance would be termed Foucault currents.

In the station just referred to the supply pipe was 12 inches in diameter and the crane 10 inches; the distance as stated was 350 feet, and the discharge was 1,600 gallons in 25 seconds, or at the rate of 3,840 gallons a minute. Under the same conditions, with 1,000 feet of 12-inch pipe and a similar crane, this flow was reduced to 3,000 per minute, due solely to friction. Comparing this again with Johnson's table, above referred to, we find that we should have obtained 3,300 gallons.

Again, on a recent test with an 8-inch crane and 1,300 feet of 8-inch pipe under 125 pounds pressure the rate of delivery was 3,500 gallons per minute. Consulting the same table we have as the theoretical output 3,535 gallons. That pipe line is too smooth and straight, and I have written for a verification and new time test.

The objections to the water crane are that it is an expensive adjunct to a tank (most of the devices of this kind not being adapted to city water mains direct), and they are time consumers, taking many minutes more than the direct method of using tank fixtures. This latter objection more nearly applies to the old-time sizes of crane, viz.: 4, 6 and 8 inch, as the foregoing results will show.

An old coal mine near Portsmouth, Rhode Island, is to be opened with a view of selling the coal for fuel in the form of briquettes. "The Engineering and Mining Journal" says that the quality of the coal formerly mined there was not of the best, and notes an old jest to the effect that it was the only absolutely fireproof material known. The opening of a coal mine in that section is interesting, no matter what the quality.

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The Directory of Officials of the Railroads of the United States and Canada, which has been printed and regularly revised in our paper since the publication of the first issue of the National Car Builder, has been consolidated with the Pocket List of Railroad Officials, published quarterly by The Railway Equipment & Publication Co., 24 Park Place, New York. This Pocket List is exceedingly complete. It is revised with the greatest care, and because of its convenient form, it is very handy for the satchel and the desk. The consolidation is a fitting one, and our friends who have found this feature of the "Car Builder" advantageous need not miss our directory, because they have a better one. We have published our directory for so many years that it is hard to let it go, but the change is believed to be in the interest of improvement, and it is a benefit to our readers.

In consideration of the large proportion of the expenditure for equipment and maintenance in the mechanical, bridge and way departments of railroads, and on account of the difficulties in the way of keeping proper checks upon their operation, it is very important that the administration should be intelligent and businesslike. As a rule, the control of these departments is intrusted to general officers, who, while admirably competent and efficient as to methods of train operation, are not equally qualified to manage and decide engineering matters. It is becoming more evident every year that the final decisions should be intrusted to officers who are either thoroughly qualified by experience to decide them, or are possessed of the commercial faculties which will enable them to settle them on what may be called a business basis. Several examples have recently forced the conclusion that this subject needs attention. Either the engineering officers should be general managers of their departments, which all good ones are qualified to be, or they should be responsible to those who are competent to direct their actions in large matters, and who are able to give important subjects the attention they require. It would give point to these remarks to name specific cases. This will not be done here, but it is not difficult for railroad managements to find out whether it applies to them. The roads are rare upon which in engineering management, and particularly as regards the mechanical departments, vast improvements may not be made.

The breakage of piston rods, which was the subject of several articles in our last two issues, has called forth a vigorous response from a correspondent, who gives reasons for several failures coming to his attention that are absurd enough to merit notice. He cites a case of a class of engine on a large road (where the officers ought to know better) in which a desired increase of power was obtained by increasing the boiler pressure from 160 to 180 pounds without any changes except in the boilers. The same cylinders, piston rods and crossheads were used, and the piston rods gave trouble at the start. If the parts were large enough for the previous condition, which, however, is somewhat doubtful, they proved at once to be too small for their increased duties. But this was not the worst that our correspondent had to say. He also told of a road, and it must be a small one, upon which the crosshead ends of piston rods were not enlarged in the natural course of increasing the dimensions of engines, merely because the Master Mechanic objected to carrying another size of reamer in the tool room stock. It is to be hoped that all of his piston rods broke until this idea of economy was overcome. These cases are well vouched for, and no further comment is necessary, except to call attention to the treatment of the subject of fiber stress in the articles that we have printed from the pen of Mr. Francis J. Cole.

## INCREASED PISTON STROKE.

The present tendency toward increasing the stroke of locomotives raises the question in many minds as to the value of the change and the extent to which it is advisable to go in this direction. A correspondent asks us whether it is desirable to adopt 26 inches as common practice and whether it is advisable or desirable to exceed this.

Mr. G. R. Henderson's excellent presentation of the subject of cylinder capacity in this issue is specially valuable at this time and it will answer some of the queries that have been raised.

There are several advantages to be gained by increasing stroke, some of which are in the nature of steam engineering and the others are purely mechanical. Among the former are: Reduced clearances, reduced steam condensing surface and less initial condensation of the steam. On the other hand, the increased stroke causes higher piston speeds, but the effect of this is probably much more than offset by the gain in connection with the clearance and condensing surfaces.

Starting power may be increased by lengthening the stroke or by decreasing the size of driving wheel. This also applies to pulling power when running and influences the ability to climb grades or to pull heavy trains, providing, of course, that the boiler capacity is sufficient, and lengthening stroke within proper limits will be advantageous for fast and heavy stock, meat and tea trains.

Large cylinder power may be obtained by increasing diameter or lengthening stroke. The former method is limited in very

large engines by the clearance width of the road, and when it is necessary to provide large cylinders the diameter is kept down for this and another important reason. The stresses from the steam pressure on the running gear are higher with large cylinder diameters. By selecting a cylinder with smaller diameter and longer stroke the stresses on the piston, piston rod, main and side rods, crank pins, axles and driving boxes are reduced, these parts may be made lighter and the weight may be put into the boiler, where it will do the greatest amount of good.

The limit to the increase of stroke is not to be stated in figures, but in the relations between the dimensions of diameter of cylinders and wheels, considering the work the engine is to do. Thirty-four inches is the maximum stroke thus far used in freight engines, but it is not expected that this will be reached in passenger engines on account of the piston speed. Very long stroke is satisfactory in slow service, and while 24 inches will doubtless be exceeded in passenger engines and 26 and even 28 inches will be used in some cases, the necessity of keeping the piston speed down will tend to prevent the use of strokes longer than these for this service.

## THE PRESENT STATUS OF THE COMPOUND LOCOMOTIVE.

There must be good reasons for the wide differences of opinion of well informed railroad officers with regard to the value of the compound locomotive as a type, and because of the attitude of several of these, which has led them to issue instructions to their subordinates "that no more compounds are to be bought or built," we shall review what appears to be the most important of them.

Many little difficulties, common to all mechanical development, have been found in compounds, and most of them overcome, but the chief reason for the failure of the type to become generally popular is that in the earlier days the cylinder power was insufficient and the compound was not a success as a factor in operation. The question of first importance in designing a compound is to give it the ability to handle heavy trains. When the type reaches the stage of being satisfactory from an operating standpoint it is almost certain to be satisfactory as to economy. The two go hand in hand. The present tendency in increasing cylinder power is in the right direction, and the result is likely to be a change of conditions that will favor the compound and the type will probably occupy a very prominent place in future practice.

Under present conditions weakness in a locomotive means wastefulness in operation, and as an example of the effect of light trains on the coal records, the following figures are quoted from the results of a recent experiment on a prominent Western road. They are taken from the performance of heavy and light trains on the same division, and give the average of a group of several men, in order to eliminate the effect of different methods of handling:

| Average Tons in Train for Month. | Pounds Coal per 100 Ton-Miles for Month. |
|---|---|
| 842 | 16.2 |
| 716 | 17.8 |
| 543 | 19.4 |
| 482 | 22 8 |

It must be borne in mind, however, that speed must be considered, because light trains are usually fast ones, and some of the differences in this table are due to this fact. The higher speeds in this case probably account for less than half the difference in the coal burned. In this case a reduction of about 40 per cent. in the weight of the train caused an increase of about 40 per cent. in the amount of fuel burned per 100 ton-miles.

Many comparative tests have been made between simples and compounds, and an illustration of the fact that the importance of cylinder power is not appreciated is seen in the case of a test made recently between a compound designed for more than 200 pounds steam pressure, while the simple engine was working with but 180 pounds. In an attempt to operate the two under similar conditions the pressure of the compound was reduced to 180 pounds, to correspond with the simple engine. The idea was correct, as the two types ought to be compared on the same basis, but the fact that the compound had been designed for higher pressure was overlooked. The effect of the change was to rob the compound of cylinder power, and the result was a failure of the type to make the favorable showing that was expected. The deficiency in power was a serious handicap, which, in this case, the advantages of compounding were unable to overcome. It has been customary to insist that the boiler capacities of simple and compound engines that are tested in comparison should be equal, and the really vital factor of equal cylinder capacity has sometimes, even often, been overlooked.

Troubles were had with some of the earlier forms of intercepting valves, and a number of minor difficulties have been found in connection with lubrication and the use of relief valves, but most of these have been overcome, and the rest will not long prove difficult. The compound has also been handicapped because it has not been as handy as a simple engine in switching and in backing out of sidings. Another factor is that enginemen have not been sufficiently familiar with the type to give it a fair chance. This is proven by the necessity for providing a check upon the incorrect use of the starting valve as worked out on the Philadelphia & Reading and illustrated elsewhere in this issue. The draft on the fire, being lighter than in a simple engine, requires lighter firing and the fire must be kept thinner. When all the enginemen who are called upon to handle compounds have sufficient experience to understand them thoroughly they are bound to give better results. There is an additional feature that operates against the compound in the fact that the margin between a proper load and an overload seems to be smaller than in the other type. The effect of this was more serious when cylinder powers were less. Whatever the reason for this, it tends to show the importance of adjusting the tonnage rating with considerable care. It is to be expected that a new type will spend more time in the shop than an old one, but when the compound has had the study and development that have been devoted to the simple engine, there should be no differences in the cost of repairs. The weak points will be discovered and the designs improved. At least three prominent superintendents of motive power, having had extended experiences with various designs of compounds, are even now prepared to show that they are able to maintain some of their compounds as cheaply as corresponding simple engines.

The reason why the compound will be used is that when given work to which it is adapted it will consume less fuel and water for the same tonnage handled by a simple engine. The fuel economy is the chief item, but when bad water must be used the compound has the advantage of using as little of it as possible. If the compound will save 10 per cent. in fuel, and do it day after day, without undue attention, it will offer one of the cheapest ways for a railroad to save money; and when the type is more thoroughly understood it will be accepted on this basis as a constant source of economy. Fifteen per cent. will be obtained in many cases, but 10 per cent. is stated as a conservative proportion. The reason for the economical operation is in the smaller range of temperatures being the expansion. This has important influences over the condensation and re-evaporation of steam in the cylinders, and permits more work to be done without using more steam.

Many want to know when they ought to use compounds and when simples. We should say that whenever the average work done by a simple engine is so great as to necessitate running at an uneconomical point of cut-off, or over ⅓ stroke or ½ stroke, the compound may be expected to do the same work with a saving in fuel. When the speed is high, and the cut-off shortens, the compound has less opportunity to save fuel. This applies to both freight and passenger service and to the average work of the engine. When most of the work of a division is light and the full stroke capacity of the engine is required only a few times in every trip, while the rest is comparatively easy work and the time fast, the compound would be at a dis-

advantage. Of course, operating conditions must be considered, and pusher engines should be used where conditions favor them, but after operating questions have been disposed of the question of the compound may be summed up as stated. With light loads there is nothing to be gained by compounding, and if the experience of English railroads in compounding is having any influence on opinion in this country, it is important that those influenced should study the differences in the conditions in the two countries.

## NOTES.

The "Penacook," a new Government tugboat, recently launched at the Brooklyn Navy Yard, is of steel and 75 feet long. The work upon her has all been done with pneumatic tools.

A total number of 1,538,764 passengers were carried by the surface and elevated railroads of Chicago on October 19, the occasion of the Peace Jubilee parade and the visit of President McKinley.

A train on the Erie on October 24 ran 20 miles with the engineer dead from striking his head against some obstruction. The engine was of the Wootten type, with the fireman and engineer separated by half the length of the boiler. The fireman's attention was attracted by unusual speed, and he soon stopped the train.

The danger from the narrow range of water level in water tube marine boilers receives emphasis from the bursting of several tubes on the U. S. torpedo boat "Davis" while running her official trial at Astoria, Oregon, recently. Three men were killed instantly and four more died after terrible suffering. The explanation offered is that "low water" occurred through a failure of the automatic water regulator.

"Bilgram's Diagram and the Solution of Problems Involving Lead" is the subject of a brief article by Mr. Merrill Van G. Smith, in the Journal of the Franklin Institute for November. The object is to show that by a simple construction not only an approximate but an exact solution of the angular advance, lap and eccentricity may be found when the point of cut off, lead and port of opening are given.

In commenting upon the possibilities in the development of locomotives and railroad transportation, "Engineering News" shows that the "largest locomotive in the world," that we illustrated last month, is probably able to pull a train carrying 3,375 tons of grain, or a fair-sized cargo for a Lake steamer. This engine has a load of 26,000 pounds on each driving wheel, which exceeds all previous practice. The big engine is here to stay, and bridge men must get their structures strong enough for it.

A convenient method for unloading logs from special logging cars has been introduced on the Chicago & Northwestern by Mr. C. A. Schroyer, Superintendent of the Car Department. Short flat cars are used for the logging business, and skids made of old rails are placed at intervals of about six feet along the floor. The bottom logs are held in place by latches released by chains laid on the floor beside the skids. In unloading the car a man releases the latches on the side opposite to that at which he stands. He then raises the side of the car about ten inches by means of jacks and the load rolls off bodily.

The cost of electric power was the subject of an elaborate paper by Mr. R. W. Conant, read before the Boston meeting of the American Street Railway Association. In studying the cost of operation of 44 power stations in different cities he found that the cost of power alone for the past year was $1,825,000, and if the power had been produced by all at the rate of the most economical plant, a saving of $443,300 would have been made. The conditions were not equally favorable in all cases, but this statement shows the importance of good designing and care in management.

Long locomotive runs are made on the Sunset Limited of the Southern Pacific. The distance between Algiers, La., and Oakland, Cal., 2,484 miles, is made by nine engines. The division points taken from Oakland are: Bakersfield, 314 miles; Los Angeles, 168 miles; Yuma, 250 miles; Tucson, 251 miles; El Paso, 312 miles; Sanderson, 316 miles; San Antonio, 308 miles; Houston, 209 miles, and Algiers, 362 miles. A continuous run of 119 miles without a stop is made on the division between Los Angeles and Yuma, and a helper is used on Tehachapi Mountain, between Bakersville and Los Angeles. The crews are changed at several points intermediate between those stated.

The Chief of the Bureau of Ordnance U. S. Navy, Capt. O'Neill, says: "Experience has shown that guns in turrets operated by electric power can be laid upon and more accurately made to follow a moving target than when operated by steam, hydraulic or pneumatic power. There are no water pipes to freeze, no steam pipes to burst, and no delay in obtaining a full working pressure, and no troublesome or noisy exhaust pipes to deal with. A burned-out fuse can be replaced quickly or a broken wire repaired, and as the wires can be led below the armored deck, there is little liability of the latter becoming necessary."

In repairing a locomotive firebox much time and inconvenience may be saved by turning the boiler over to bring the mud ring on top, and this is the practice of several builders in new construction. The advantage is that more men may work on the boiler without getting in each other's way, and by comparing the ordinary method of working on the inside of a firebox or on the mud ring, when the boiler is in its natural position with the other method, the awkwardness of the former is apparent. The cylinders must, of course, be removed, but instead of being a disadvantage this is often necessary any way, and it is desirable that the connection between the saddles and the smoke box should occasionally be renewed. The cost of the additional work required may be placed at about $20, and at the Chicago & Northwestern shops, where the boilers are inverted, the saving by reason of the convenience of the work is estimated at between $40 and $50 on each engine. The front end of the shell, after the cylinders are out of the way, rests on wooden blocking, and the back end is supported by a trunnion in a plate that is bolted to the fire door hole, the trunnion being carried on a frame made of an arch of an old 8-inch I-beam on a base of planks.

A simple formula for the capacity of fans of the centrifugal type that is said to be remarkably accurate has recently been devised by Prof. R. C. Carpenter, of Cornell University. From a large number of experiments, it was found that the number of cubic feet of air discharged in one revolution of the fan was equal to the cube of the diameter of the fan expressed in feet, multiplied by the constant 0.5, if there was a free delivery, and 0.4 if the pressure was about that found in ordinary blower practice; or equal to the pressure of one and one-half inches of water.—"Engineering Record."

## PNEUMATIC RIVETING BY PORTABLE MACHINES.

The Chicago Ship Building Company has been using pneumatic riveters in its ship yards for the past three years, and Mr. W. I. Babcock, manager of the company, gave some interesting statements in regard to the results in a paper presented at the recent meeting of the Society of Naval Architects and Marine Engineers.

As a result of this experience this concern is now able to drive every rivet in a ship by power machines, operated by unskilled labor, and in the last ship built by them over 250,000 out of a total of 340,000 rivets were so driven, the lack of

sufficient air capacity being the reason for not driving them all in that way.

In beginning the work a horizontal stationary steam riveter was used, having a 5-foot reach, and with it 1,800 rivets were driven in ten hours, costing one-half cent each, the work in this case being brought to the machine, saving about 2½ cents over hand work. Compressed air then recommends itself for portable machines because it would not freeze, and pneumatic power was required at the works for working hammers, calking machines and reamers. Two years ago a 72-inch and a 45-inch bow machine were put in. The first weighed 2,500 pounds and the second 1,700 pounds, but they were awkward in handling and soon gave place to pneumatic hammers used in connection with a pneumatic holder on. The next step was to combine the hammer with the holder on by a light frame in the shape of a horseshoe. The frame being of iron pipe, and so light that one with a reach of 9 inches weighed 83 pounds, another with 52-inch reach weighed 160 pounds, and with a 70-inch reach 220 pounds. The result of this experiment was to secure an improvement over hand work, as the rivets were driven hotter than by hand. Convenient methods of holding the machines and transporting them were provided. In deck work, where a pneumatic holder on is used from underneath, three men and a boy, for heating the rivets, drive from 800 to 1,000 in a day.

In concluding the paper Mr. Babcock says that "The unanimous opinion of the hull inspectors, who have been in duty in our yard for two years and more, is that the rivets are first class in every respect, and make far better and tighter work than those driven by hand. As for the cost, I will say that, adding cost of air, repairs, etc., the saving is from 1 to 2 cents per rivet over piece work prices for hand riveting, depending upon the location in the ship, and averaging about 1¼ cents. In an ordinary lake steamer of 4,000 tons the saving is from $4,000 to $5,000 over hand work.

"In conclusion I want to say that the quality of the work done by portable pneumatic riveters in ship building is such that the various classification societies cannot ignore it, and before very long will doubtless recommend, if not require, that all rivets in at least the principal portions of the ship be driven by power."

This experience corroborates that illustrated on page 378 of our November issue, and, if we are correctly informed, the machines used by the Chicago Ship Building Company were furnished by the Chicago Pneumatic Tool Company.

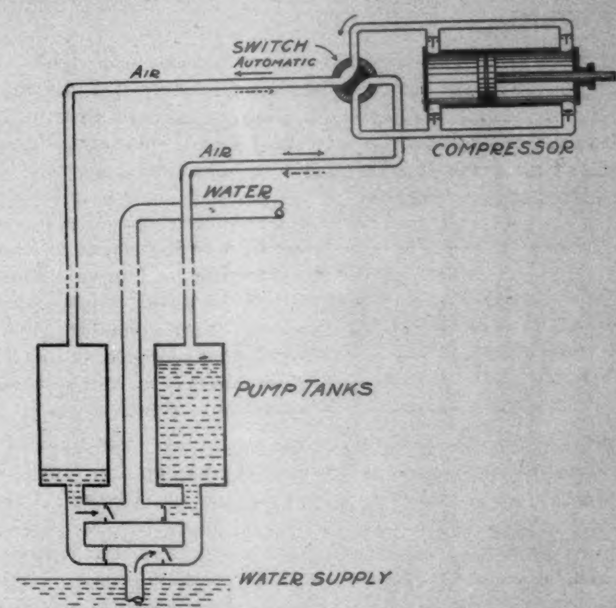
## WATER TUBE BOILERS MEET AN EMERGENCY IN THE NAVY.

The Babcock & Wilcox Company received special mention in the annual report of Commodore Melville, Chief of the Bureau of Steam Engineering, U. S. N., for their work in the emergency of preparing vessels for use in the recent war, his commendation being expressed as follows: "The work immediately necessary on the breaking out of the war was not so much extensive repairs to ships in commission as the fitting out of every available ship in ordinary so as to get some service out of each one in the possible crisis. The old single turret monitors were susceptible of fair use as harbor defense vessels if they could quickly be made seaworthy, and one of the most notable engineering feats was in connection with this work. This consisted in the actual cutting out of the old and worn-out boilers of the monitors Manhattan, Mahopac and Canonicus, at League Island, and erecting new boilers in their places without cutting the decks, and all within the space of thirty days. The boilers as cut up were passed out through the smoke pipe opening and the new sections put down the same way, the results proving most satisfactory. This work was done by the Babcock & Wilcox Company, under contract, and this firm deserves great credit for the expedition with which the work was done. It was well known that these vessels could not be used unless new boilers were fitted, and before war was declared the Bureau had ascertained that the firm mentioned was the only one which could do the work in less than three months. Arrangements for beginning the work promptly had been made, and in less than five hours after the new boilers were authorized by the Department the work of building them was commenced. It is a source of satisfaction that the performance of these vessels with the new boilers exceeded that when the vessels were first built."

## THE HARRIS COMPOUND DIRECT AIR PRESSURE PUMP.

A new system of pumping by compressed air is being introduced by the Pneumatic Engineering Company, 100 Broadway, New York, that appears to be a great improvement over methods previously used in the direct application of air pressure to the pumping of water. Air lift pumps are not new, but this system employs an arrangement which, while avoiding complications of floats and valves, utilizes the pressure of the air directly upon the water in a new way, in which what may be called the exhaust air is used to assist the compressor instead of being wasted at high pressure.

The engraving shows a simple application of a pump to a single source and a single lift. The pump has a suction and discharge pipe and two pump tanks, which are alternately opened to the suction and discharge. The air compressor is connected to the tops of the tanks by air pipes leading to an automatic valve or switch near the compressor. With the switch in the position shown the compressor is forcing air




The Harris Direct Air Pressure Pump.

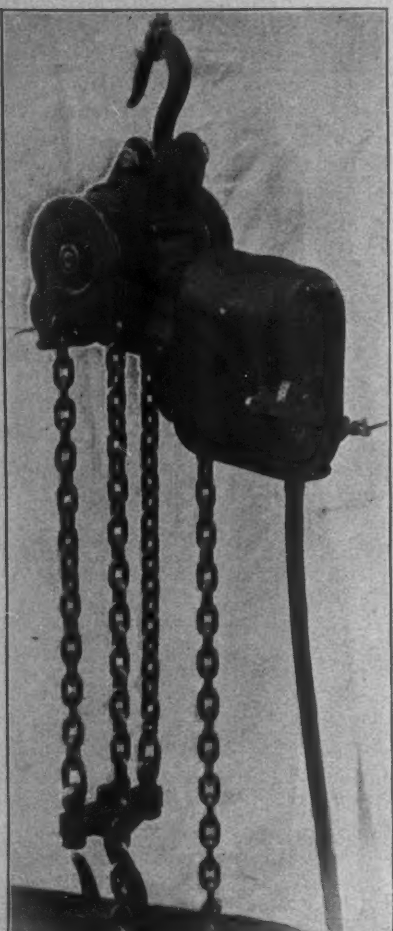
down through the pipe at the left, driving the water from the left-hand cylinder into the discharge pipe, the suction side of the compressor is connected to the right-hand air pipe and the right-hand tank is filled from the water supply. When this tank is empty the switch automatically changes its position and reverses the pipe connections, forcing the water from the right-hand tank into the discharge. The automatic operation of the switch may be effected in one of several ways, one of which is by mechanism that will change its position after a certain number of strokes of the pump, which is determined by experiment. In case more air is pumped than is needed the surplus will escape through the water discharge, and in case too little air is pumped, some of the water will remain in the pump tank, reducing the output of the apparatus, but these matters may be readily adjusted by the man in charge of the compressor.

With deep pumping the lift may be divided into two or more stages, but it is stated that a compound compressor may be used against a head of 200 feet or more. One of the peculiar advantages urged for the system is that one compressor may be used for a large number of wells, which may be widely separated from each other and from the compressor. The system is also adapted for fire protection.

The system has fewer mechanical complications than any pump used, except that known as the "air lift." It is claimed that in a properly proportioned system the losses outside of the compressor, including the friction in the air and water pipes and expansion in the air pipes, will not exceed 20 per cent. The system was developed and patented by Elmo G. Harris, C. E., Professor of Civil Engineering in the School of Mines of the University of Missouri.

## PNEUMATIC CHAIN HOIST, WITH REVERSIBLE MOTOR—THE CHICAGO PNEUMATIC TOOL CO.

The chain hoist has long been one of the favorite devices for use about shops and machinery. Its special advantages are that it is powerful and holds the load at any height, it is light and easily attached, which, together with the fact that it may be operated where there is comparatively little head room, explains its popularity and extensive use. The only disadvantage of the chain hoist when operated by hand is its slowness, but this is overcome by the attachment of an air motor, such as the one shown in the accompanying engraving, and the arrangement has certain advantages over all other forms of air lifts. There is no movement of the load caused by leakage of a piston or jumping of a part of the load when another part is suddenly removed, such as occurs with many cylinder hoists, and the height to which the load is raised may be nicely adjusted by a chain hoist, which is a convenience in putting axles or other pieces into lathes.



Pneumatic Chain Hoist.
CHICAGO PNEUMATIC TOOL CO.

The hoist shown is manufactured and sold by the Chicago Pneumatic Tool Co. It is operated by a Whitelaw reversible air motor, and without the chain it weighs 40 pounds, and this size will lift 800 pounds. It is made in two sizes, the larger one having about double the capacity of the one illustrated. The motor is intended to work at a pressure of about 80 pounds per square inch, and the size illustrated consumes only 10 cubic feet of free air per minute. The motor may be reversed at any time, giving complete control of the load. The throttle is governed by the bar attached to the rear of the motor, and ropes hanging from holes in the bar are fitted with handles for operating the hoist. The ingenious construction of the hoist is clearly seen in the engraving.

## THE AIR-BRAKE SITUATION.

The Westinghouse Air-Brake Company authorizes the following statement in regard to the New York and Boyden Companies:

"The purchase by the Westinghouse Air-Brake Company of the patents and business of the Boyden Brake Company is the final conclusion of a long and interesting litigation relating to air-brakes.

"The course of these suits has been followed with interest by railroad men, because, to a considerable extent, they involved the right of the Westinghouse people to the sole manufacture of what is known as the "Quick Action" brake. By the purchase of the Boyden inventions, which the Supreme Court said were highly meritorious, the Westinghouse company still claim to control the situation, although this is contested in the United States courts by the New York Air-Brake Company. The Westinghouse company have been successful in compelling the New York Company to cease making three different forms of brakes, and they claim that a fourth one which they are now putting on the market is also an infringement of their patents. This question will be finally determined by the Court of Appeals, probably in November or December, the opinion of the lower court having been favorable to the New York company. Should the decision be favorable to Westinghouse, then the New York company will once more be enjoined and prevented from making their present style of brake.

"In addition to this particular suit, it appears that the Westinghouse people have brought three other suits against the New York company, and it would, therefore, look as if litigation between these two concerns was to be, if anything, more protracted than that between the Boyden and Westinghouse companies."

## BREAKAGE OF M. C. B. COUPLERS.

Mr. P. H. Peck, Master Mechanic of the Chicago & Western Indiana, in a paper read before the Western Railway Club, makes the following observations with regard to the breakage of M. C. B. couplers:

I find, from the records kept in my office for the past six and one-half years, that as the number of M. C. B. bars handled increased, the percentage of broken bars and of broken knuckles decreased, as shown by the following table:

| Year. | Per cent. M. C. B. bars. | No. cars. to 1 bar broken. | No. cars. to knuckles broken. |
|---|---|---|---|
| 1892 | 8 per cent. | 377 | 2,476 |
| 1893 | 15 per cent. | 385 | 1,684 |
| 1894 | 20 per cent. | 424 | 1 609 |
| 1895 | 28 per cent. | 620 | 1,663 |
| 1896 | 42 per cent. | 996 | 2,345 |
| 1897 | 48 per cent. | 1,240 | 2,573 |
| 1898 | 59 per cent. | 1,872 | 3,047 |

A large proportion of the breakage of knuckles occurs when an M. C. B. coupler is coupled with a link and pin bar, such breakages being most likely to occur in heavy trains. In some cases the coupling is made by the pin being placed through only the top hole of the knuckle and into the link; this either breaks the top lug off or breaks out the pin hole; in other cases the knuckles may be broken when two cars strike together and both knuckles are closed. Very few M. C. B. bars are broken when two of these bars are coupled together. Included in our own equipment we have 88 cars and 22 locomotives equipped with M. C. B. couplers; 32 cars equipped last year and the locomotives equipped within the last eight months. As yet we have had but one knuckle broken (that on a car) and that was caused by an accident. One of the engines equipped in this manner is double-crewed most of the time for service both night and day. This serves to illustrate the fact that the proportion of breakage to M. C. B. couplers on switching roads is much less than many believe to be the case.

I do not find, in actual practice, the trouble anticipated by Mr. P. Leeds, in his paper before the Central Association of Railroad Officers, expressed as follows: "Flange wear or crowding the flanges against the rail, or that the bar is not strong enough for our modern 80,000 and 90,000-pound capacity cars. We handle hundreds of these cars and the number of breakages of couplers is no greater than with other cars. We do find, however, that when these heavy cars strike very hard the load shifts, in some instances forcing the end out of the car, but not breaking the bar. I have seen cases of rear end collisions and trains breaking in two, and have found that in such accidents the damage to M. C. B. bars was not one-fourth as great as that to link and pin bars. Cars are not as liable to telescope when equipped with M. C. B. couplers as when equipped with link and pin drawbars."

The new station of the Pennsylvania Railroad at Jersey City, that is to replace the one recently destroyed by fire, is progressing rapidly. The new station will have a steel frame sheathed with copper, and the train shed is to be extended 125 feet toward the water. It will then be 777 feet long and 256 feet wide. The waiting room will be 80×97 feet, including the ticket and telegraph offices and telephone room. Two spaces 40×65 feet will be occupied by the restaurant and dining rooms. The improvements will cost $400,000, and the arrangement of the rooms will be more convenient, and passengers will go directly from the ferry to the trains by a distance shorter than before.

## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

### Chemistry Applied to Railroads—Second Series—Chemical Methods.

### XXV.—Method of Determining Tin in Phosphor-Bronze.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

#### Explanatory.

Phosphor-bronze, as is well known, is normally an alloy of copper, tin and phosphorus, the proportions of the three constituents varying somewhat with the use to which the alloy is to be put. Phosphor-bronze bearing metal, on the other hand, contains lead, in addition to the other constituents, the usual proportions being a little over 79 per cent. of copper, 10 per cent. each of lead and tin and a little less than 1.00 per cent. of phosphorus. There may be a number of other elements present as impurities, zinc and iron being the most common. The

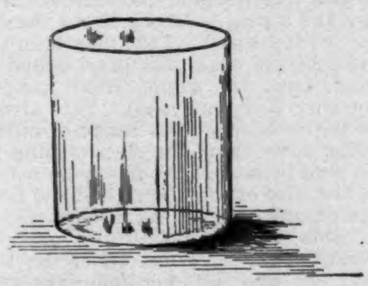


FIG. 1.

importance of a sufficiently rapid and reliable method of determining tin in this alloy is very great. Excepting the phosphorus, the tin is the most expensive constituent, and the amount of phosphor-bronze bearing metal, or closely related alloys in use at the present time, is something enormous. In

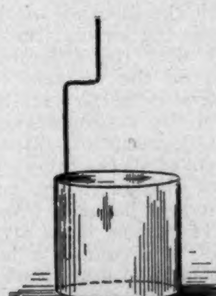


FIG. 2.

FIG. 3.

our laboratory alone at present the number of bronze analyses averages not less than 15 per month. Until recently the method we have used has been to weigh the tin as oxide. This method was described in full in article Number IX. of this series, published in the "American Engineer and Railroad Journal" for August, 1894. The method described below offers some advantages over the one previously used, both in requiring less manipulation, with consequent greater output of results, and in accuracy, and accordingly has been largely used for some months. It is applicable to all copper, tin, lead, phosphorus and copper, tin alloys, where the amount of copper, or of copper and lead together, reaches 75 to 80 per cent., and where these alloys do not contain considerable amounts of disturbing elements, as described below. It is not recommended for use with any of the white metal alloys, as there is a simpler method of treating these alloys.

#### Operation.

Dissolve 1 gram of fine borings in 20 c. c. of C. P. nitric acid, 1.20 specific gravity, and evaporate until the residue will not adhere to a dry glass rod. Add 10 c. c. of concentrated C. P. nitric acid, 1.42 specific gravity; heat where the temperature is about 275 degrees for 10 minutes; add 75 c. c. of distilled water; stir thoroughly; heat nearly to boiling for 10 or 15 minutes to facilitate separation of the precipitate, allow to settle a little and then filter, washing with distilled water until a drop of the filtrate, evaporated on a piece of clean platinum foil, leaves no residue. Set the filtrate aside to be used later in the determination of the lead and copper. Put the filter, with the hydrated metastannic acid on it, back into the

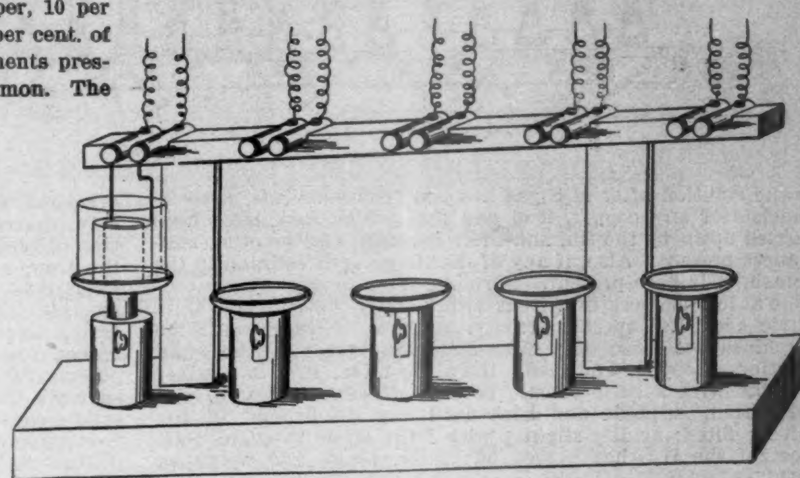


FIG. 4.

same beaker, taking care to spread out the filter, and add 10 c. c. of caustic potash solution and 10 c. c. of water, and heat until the metastannic acid is dissolved. The hydrated metastannic acid obtained, as above described, is apt to carry with it copper, iron, lead and possibly arsenic, antimony and zinc. It may also have a little tin in such condition that it does not completely dissolve in the caustic potash solution. These impurities usually adhere to the filter, and the milky appearance characteristic of the liquid, when the caustic potash is first added, soon disappears, so that, when the liquid is clear, or pretty nearly so, especially if the heating has continued 15 minutes, it may be assumed that the action of the potash is complete. Add now 100 c. c. of oxalic acid solution; heat just to boiling and maintain at this temperature for an hour, at the same time passing $H_2S$ gas through the solution. The liquid boiled away during this operation must be replaced from time to time Filter at once into a beaker holding about 250 c. c. Wash at first with 25 c. c. of the oxalic acid solution, and then with distilled water, until the volume of the filtrate amounts to 200 c. c. Heat on the steam plate until the $H_2S$ gas is driven off pretty completely; add 3 c. c. of ammonia, 0.96 specific gravity; cool and electrolyze. For this purpose have ready the electrical arrangements described below, or the equivalent of these. Attach the zinc pole of the battery, or its equivalent, if other source of electricity is used, to the larger electrode, which has been previously carefully cleaned, dried and weighed, and the other pole of the battery, or source of electricity, to the other electrode, and cover with a watch glass cut in halves. Allow a current of from 0.05 to 0.10 of an ampere to pass from 12 to 24 hours. When it is deemed that the current has passed long enough, wash down the material spattered on the covers and add water from the spritz end of the wash bottle (taking pains to stir the liquid a little) until the level of the liquid is raised a fourth or half an inch. Allow the current to pass one or two hours longer, and if the bright

stem of the tin pole, around which the liquid has been raised by the addition of the water does not show any deposit of tin, it is safe to assume that all but a slight trace of the tin has been removed from the solution. If the stem of the tin pole shows tin when treated as above, continue the current some time longer, and then repeat the test until the stem remains clean after the current has passed at least an hour subsequent to the last addition of water. By the action of the current the solution gradually becomes alkaline. When this is the case, as shown by test paper, it is safe to assume that the electrolysis is complete. The tin being satisfactorily deposited, lower the stand on which the beaker rests, detach the tin pole, dip in distilled water to wash off the liquid containing salts and repeat with fresh distilled water, then dip in alcohol, dry thoroughly and weigh.

Returning now to the material left on the filter from the oxalic solution after $H_2S$ gas has been passed. This material consists of any copper, lead and zinc which may have been carried down by the tin, and there may likewise be other substances present. Also, if any of the tin escaped solution in the potash, it is here present. Burn the filter in a porcelain crucible at low temperature; treat with 5 c. c. of concentrated C. P. nitric acid, 1.42 specific gravity, and 5 c. c. water until the sulphides are dissolved; filter and add filtrate to the main solution of copper and lead. Burn the filter; fuse in a silver crucible with a little caustic potash; dissolve in water; add ammonium sulphide and heat until any tin present is dissolved; filted; acidify slightly with HCl; allow to stand until most of the $H_2S$ has passed off; filter, ignite and weigh as $SnO_2$.

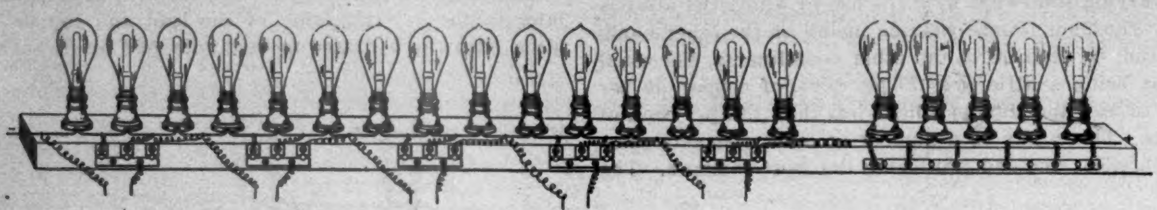


FIG. 5.

### Apparatus and Re-Agents.

A small beaker, about 2½ inches in diameter at the bottom and 3¼ inches high, can be used for the electrolysis; but a jar, made for the purpose, shown in the cut Fig. 1, of the dimensions given above, and about 2¾ inches in diameter at the top, avoids the flange and lip of the beaker, which are apt to be in the way.

The larger electrode, shown in Fig. 2, is a cylinder of platinum foil, open at both ends, 1⅞ inches high and 2 inches in diameter. The wire support is 3-64 inch in diameter, and is riveted to the cylinder. It has an offset to adapt it to the binding posts of the electrical arrangement. The wire projects about 3 inches above the cylinder. This electrode weighs 15 to 18 grams.

The smaller electrode, shown in Fig. 3, is likewise a cylinder of platinum foil, open at both ends, 1 5-16 inches in diameter and same height as the larger electrode. The wire support is same size wire, projects same distance above the cylinder, and is likewise riveted to it. This electrode weighs about 12 grams.

The supports for holding the electrolyzing jars during electrolysis are shown in Fig. 4. The material, except the set screws and binding posts, is wood. The length of the base is 2 feet and the width 6 inches. That part of the support for the electrolyzing jar which has the set screw is 2 inches in diameter and 3½ inches high. The movable part of the support for the electrolyzing jar is 3 inches in diameter at the top, and the stem is 5½ inches long. The distance from the top of the base to the bottom of the support for binding posts is 11 inches. The support for the binding post is 1 inch thick and 2 inches wide, and the binding posts are so arranged as to support the electrodes symmetrically in the electrolyzing jar. The loose ends of the wires in Fig. 4 connect with the loose ends of the wires in Fig. 5.

The difference of potential between the binding posts to which the two electrodes are attached, some two or three volts, is such that with the size of electrodes and volume of solution given above a current of from five to eight or ten hundredths of an ampere results. This difference of potential may be obtained from a battery of two or three gravity cells, but since batteries are so difficult to keep in good order, especially if they are not in constant use, and since the Edison current is so common, it is much more convenient to use this current. But the lighting system has a difference of potential of 110 volts between the two wires, and consequently some devices are necessary to bring down the voltage. The arrangement illustrated in Fig. 5 has been worked out from the suggestion given in Dr. E. F. Smith's manual of "Electro-Chemical Analysis." It is perhaps more elaborate than is necessary, but where a good deal of work must be done, it has been found to be very serviceable. It is fitted up, as will be observed, to carry on five determinations at once. The base of the arrangement is of slate, 4 inches wide, 1 inch thick and of sufficient length to carry five 16-candle-power 110-volt incandescent lamps and 15 12-candle-power 110-volt lamps. It is not essential to have the slate base all in one piece. It will be observed that all the lamps are connected in series, the right-hand end having the positive wire of the Edison current attached to it, and the left-hand end the negative. The five lamps grouped at the right of the cut are 16 candle-power, and so connected, as is readily seen, with the plugging strips on the edge of the slate that any one, two, three, four or all of them, can be cut out by simply inserting plugs in the holes made for them. The other 15 lamps are grouped in sets of three each, and are so arranged with plugging strips under each group, as is readily seen, that when the two free wires are connected through the electrolyzing solution and a plug is in one of the three holes of the group a shunt circuit is formed. If the plug is in the right-hand hole, the shunt circuit takes in three lamps; if it is changed into the next hole, the shunt circuit takes in two lamps, and if to the next hole, one lamp. This arrangement makes it possible to secure a very wide range of difference of potential at the binding posts above the electrolyzing jar. For example, if there is a plug in each of the five holes below the 16 candle-power lamps, and also one in the right-hand hole in the first group of 12 candle-power lamps, the differences of potential at the binding posts connected with this group will be about 23½ volts. Again, if all the plugs under the 16 candle-power lamps are taken out, and the plug under the first group of 12 candle-power lamps is transferred to the left-hand hole, the difference of potential between the binding posts will be about one volt. By varying the plugging, almost any desired voltage between these two extremes can be obtained. It is evident that by using lamps of different capacity, or by using more or less of them, still wider variations of voltage may be obtained. A switch, not shown in the cut, makes it possible to shut off the current when the apparatus is not in use. It is difficult to give positive directions about the plugging necessary in using the apparatus described above, since the voltage in the mains is apt to vary a little, with the distance of the apparatus from the central station; also the switch, the wires, and the plugging devices used, vary with the different constructions, with corresponding effect on the voltages in the shunt circuits. Still more important also is the variable introduced when one, two, three, four or five determinations are being made at once. Each new determination introduced changes the voltage at the binding posts of all the others which are in the circuit, with a consequent change in the current passing, and hence a change in the plugging becomes necessary to counteract this. The best course to pursue, if an arrangement as above described is made use of, is to connect a delicate ammeter in circuit with the determination and make a schedule of the plugging required when one, two, three or more determinations are being made at once. It may be said, however, that if the apparatus is approximately as described above, and one, or even two, determinations are being made at once, successful results will be obtained if there are three plugs in the group of 16 candle-power lamps, and the right-hand hole of each group of 12 candle-power lamps has a plug in it. The lamp arrangement is supported on a wooden frame, not shown, with the support for holding the electrolyzing jars underneath it. It is desirable to use porcelain sockets for the lamps, as they are not corroded by the fumes of the laboratory, and of course insulated wire should be used throughout for the connections. The plugging arrangements are made of brass and should be kept well lacquered. Turning the plugs in the holes occasionally keeps the contacts good.

The caustic potash solution for dissolving the hydrated metastannic acid is made by dissolving 200 grams of C. P. caustic potash in one liter of distilled water. This solution is not easy to filter, and should be allowed to stand and settle, the amount for use being drawn out with a pipette.

The oxalic acid solution is made by dissolving 200 grams of C. P. oxalic acid and 5 grams of oxalate of ammonia in 1 liter of distilled water and filtering. This solution is nearly a sat-

urated one, and should not be allowed to get cold enough to deposit crystals.

Calculations.

The tin on the electrode being metallic, no calculations are required. For the tin not soluble in caustic potash the following data are applicable. Of course the amount obtained must be added to the amount on the electrode.

Atomic weights used: Tin, 118; oxygen, 16; molecular formula, $SnO_2$. Since 78.67 per cent. of the binoxide is metallic tin, the weight found, expressed in grams, multiplied by this figure, gives the amount of metallic tin in the precipitate.

Notes and Precautions.

It will be noted that this method separates the tin from the mass of the copper, lead, zinc and iron associated with it in the alloy by means of nitric acid, dissolves the resulting metastannic acid first in potash and then in oxalic acid, separates the small amounts of copper, lead, zinc, arsenic and antimony, if any, carried down by the tin by means of hydrogen sulphide, and, finally, electrolyzes the tin in oxalic acid solution.

So far as our experience goes, the only element that really causes trouble in this method is iron. Whatever arsenic, antimony, copper, lead and zinc are carried down with the metastannic acid are subsequently separated as sulphides in the oxalic acid solution. But iron, aluminum, and possibly manganese, go into solution with the oxalic acid, and remain with it after treatment with $H_2S$. The subsequent behavior of manganese, and also the behavior of nickel and cobalt throughout, our work has not led us to investigate sufficiently, as yet, as these rarely occur in the bronzes we have to deal with. Of the iron and aluminum, the latter separates as $Al_2O_3$ during the electrolysis and causes no trouble. The iron goes with the tin as metal. The presence of iron in the oxalic solution is readily shown by the color. Usually, with good bronzes, the oxalic solution is water white, or so nearly so, that the iron can be ignored. If, however, this is not the case, the tin and iron on the electrode are dissolved in dilute hydrochloric acid neutralized with ammonia and treated with ammonium sulphide, the resulting sulphide of iron being filtered off. This is subsequently dissolved in dilute sulphuric acid, passed through the reductor and titrated with permanganate. The amount of metallic iron is, of course, deducted from the weight of the tin.

It is never safe to assume that all the tin has been dissolved in the potash and subsequently in the oxalic acid. Usually, in good bronzes, the amount of this tin is small, but we always find it present, and sometimes in quite considerable amount. The most reasonable explanation that we can give of this residue is that it is oxide of tin formed in the foundry while the metal is molten and ignited by the heat to such an extent as to be insoluble in almost any re-agent without fusion. This has not, however, been demonstrated.

The treatment of the metastannic acid with potash before solution in oxalic acid is essential; at least, we have not succeeded in obtaining solution of the metastannic acid without this preliminary treatment.

If $H_2S$ gas is allowed to remain in the oxalic acid solution there is danger of complications during the electrolysis, which it is better to avoid. The possibilities have not all been investigated, but the sulphur separated goes down on the smaller electrode and insulates it sufficiently to cause trouble.

As is well known, successful electrolysis of metals is easiest obtained by passing the current through double salts. The amount of potash and oxalate of ammonia used and the 3 c. c. of ammonia added just before electrolysis seem to furnish the proper amount of bases to form with the tin the necessary double salt.

Some care is required in managing the current. If too much is used, especially at first, the tin comes out spongy and sometimes discolored and black.

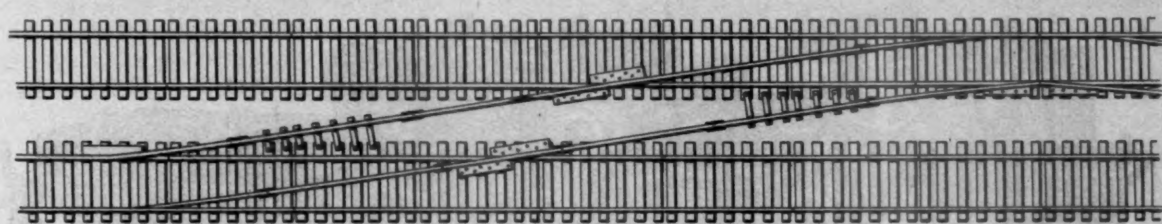
It sometimes happens that some oxide of tin separates in the liquid during the electrolysis. This peculiarity is rare, and no explanation of the behavior has been found. When it does occur it is better to start afresh.

It would be difficult to indicate all the sources from which information has been obtained in working out this method. No special claim for originality is made.

## COATES' PORTABLE EMERGENCY CROSSOVER.

The form of crossover shown in the accompanying engraving was devised by Mr. F. R. Coates, Roadmaster of the New York Division of the New York, New Haven & Hartford Railroad. Its object is to arrange all the parts necessary for a crossover connection of a double track railroad so that they may be carried as a part of the wrecking outfit and installed in a few minutes for running around a wreck or obstruction on either track. Mr. Coates tells us that under favorable conditions in daylight the various parts have been put together and an engine run over them in 6½ minutes. At night it has been made ready for use in 25 minutes, including the unloading from cars, and under ordinary conditions in daylight it may be put together in 15 minutes. The change may be made from straight track to crossover in one minute. The advantage possessed by such a device will be readily apparent.

By the use of various sized blocks under the frog and raised switch points, it is readily adapted to any size of rail. The parts of the crossover are all numbered, so as to render it easy to place them properly. The plates for making the tie extensions are attached to the base of the rail by clips, which are easily adjusted to fit the ties. Slots in the short angle bars on the frogs are constructed so that by taking a bolt in each bar and sliding the bar back the middle piece of the frog may be lifted out and it may be replaced when it is desired to use the crossover.



Coates' Emergency Crossover.

In addition to being useful at wrecks, Mr. Coates has found it convenient in single track lines for setting off steam shovels, pile drivers and camp cars, also for replacing derailed engines. This emergency crossover may be used in place of split switches at outlying sidings, which are not used frequently, its advantages in this connection being an unbroken main line, as far as this portion of the switch is concerned.

The crossover is controlled and manufactured by the Q & C Co. of Chicago and New York.

## THE NEW YORK RAILROAD CLUB.

At the annual meeting of this club, held Nov. 17, Mr. M. N. Forney presented a lecture entitled, "Conduct and Character," addressed to railroad and supply men. The meeting was unusually well attended, and the speaker had an attentive and appreciative audience. The lecture was able, full of thought and high ideal. Mr. Forney's position and long, upright career gave force to his expression, and the underlying principle throughout was, "How to do the best with our endowments." Apt quotations and illustrations, together with the speaker's pleasant way of putting things, made the evening enjoyable, as well as profitable and elevating.

Mr. H. H. Vreeland, President of the Metropolitan Street Railway, of New York City, was elected President of the club. Mr. Vreeland has had a remarkable career in railroad work, and after a varied experience on steam railroads, has reached the highest office in one of the most important street lines in this country.

A mile of railroad track rolled in an hour, is the record-breaker of the Illinois Steel Company's South Chicago rail mill one night last month, as reported in the New York "Commercial." We are not told what size of rail section was being rolled at that time, but the amount turned out by one day and one night shift is stated to be 3,004 tons.

## AN IMPROVEMENT IN FLOORING MACHINES.

A new wood-working machine, known as the "Six-Roll Double Cylinder Lightning Flooring Machine," has been placed on the market by Messrs. J. A. Fay & Co., 516 to 536 West Front street, Cincinnati, O. It is designed for the purpose of combining large capacity, efficiency and economy with durability. It is built in two sizes, to plane four sides of pieces 10 and 15 inches wide and 6 inches thick. The frame is massive and is proportioned and arranged to resist the stresses of heavy work, one feature being heavy girths under the working parts. The joints are made with care and the system of interchangeability of parts adopted by these builders is followed.

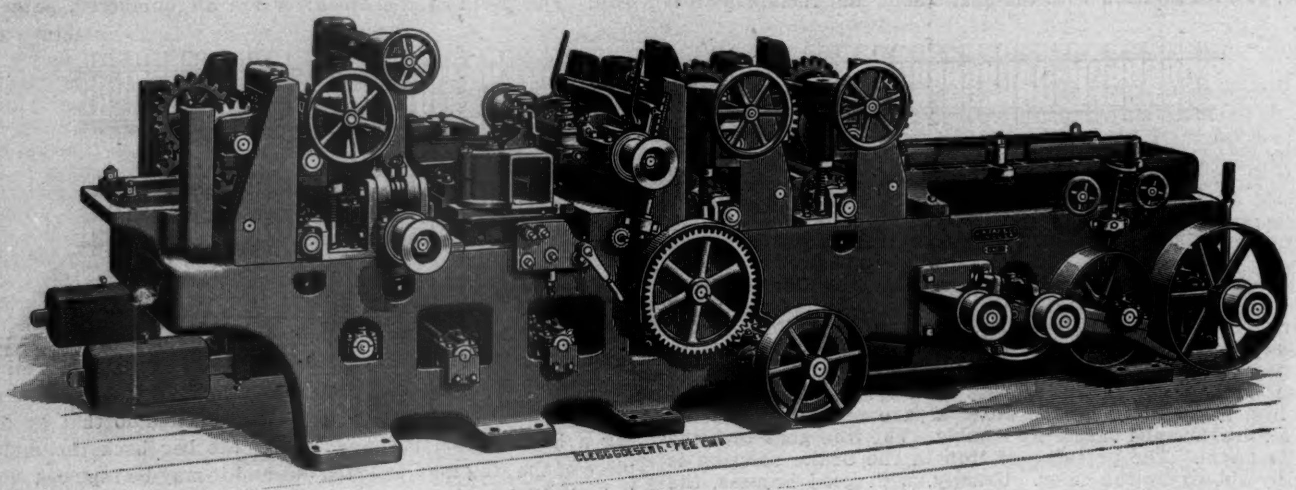
The cylinders are two in number, made from solid steel forgings, with four faces slotted to receive two or four knives and chip-breaking lips for working cross-grained lumber. The upper cylinder is mounted in a heavy yoked frame, has journals 2¼ inches in diameter and runs in self-oiling bearings 10½ inches long. It has double-flanged pulleys close to bearings on each end, fitted on taper bearings, secured with wrought nuts. The cylinder-raising screws are outside of the frame, and are fitted with ball-bearings and a device for quickly taking up all lost motion in the screw caused by wear of the threads. The lower cylinder is mounted in a heavy yoked frame. It has 2¼-inch journals in self-oiling bearings 10½ inches long, and is vertically adjustable at each end. It is driven by flange pulleys at each end.

The matching works are heavy. The arbors are of steel 1¾ inches in diameter where the cutter-heads are applied, and revolve in long, self-lubricating bearings, both of which are adjustable vertically and horizontally, and are rigidly locked in any desired position by a lever conveniently located outside the frame. The top plate of each matcher hanger is detached from the main casting for convenience and economy. It will match stock as narrow as 1½ inches. A patent weighted matcher clip has an adjustable toe, hinged to the matcher hanger to produce uniform pressure on the material. Shaving hoods are provided, which can be swung out of the way to give access to the heads.

The feed works consist of six large feed rolls, 8 inches in diameter, driven by a train of powerful gearing, each gear being on a shaft extending through the machine and running in babbited bearings. The expansion gears on the feed rolls are inside the frame, and run in bearings. The screws for raising the rolls do not revolve, the rolls being mounted in sleeve housings that travel on the screws. This makes the roll adjustment very easy, as the pressure weights are not lifted. All the roll boxes are long and large in diameter. The feed-out roll is covered and provided with scrapers. The weight levers are inside the frame, and move freely. They furnish three speeds of feed, viz., 30, 45 and 60 feet per minute. The feed is under instant and positive control of the operator by means of a lever engaging a ring friction.

The pressure bar in front of the upper cylinder is adjustable to and from the cut, and has a chilled toe to reduce wear to a minimum. The bar behind the cut is adjustable for difference in thickness of material. The bars in front of and behind the lower cylinder are adjustable to and from the cut, and are vertically adjustable for varying depths of cut. The bar over the lower cylinder is adjustable on heavy stands, and securely locked in position. It may be instantly swung over from either side by simply loosening one nut. A continuous pressure bar extends over the matching works with independent adjustment, and may be quickly thrown out of the way to give access to the heads.

This machine is equipped with a new and improved belt-tightening apparatus for both cylinder and side-head belts, permitting rapid adjustment while the machine is running, and permitting the use of endless belts, that run more smoothly and do not require to be cut for the stretch to be taken up. The riding of matcher belts, one on another, as under old methods, is avoided.



A New Six Roll Flooring Machine.

## THE TRACK TANK.

In a paper upon locomotive water supply stations, read before the Western Society of Engineers, Mr. T. W. Snow made the following unfavorable observations concerning track tanks:

"The track tank was first used by the London & North Western Railway, some thirty-odd years ago. It consists of a shallow trough about 18 inches in width and not to exceed 6 inches in depth, and of various lengths, usually 2,000 feet. Every locomotive tender must be equipped with an inclined scoop or trough, mounted on the front of which is a pony truck or pair of wheels to reduce friction, and, indeed, to enable the device to escape destruction. The speed of the train is cut down to 20 miles an hour when taking water, or at least this speed gives greatest flow. Time of delivery averages 3,000 gallons per minute. The track tank costs about $1 per lineal foot, and in a recent instance was worn out by the truck wheels in two years of service. The bottom plate was 5-16 inch in thickness. The objections to it in this climate are that an expensive steam heating plant must be maintained in winter; also, a gang of men to chip ice from the rail for the car wheel flanges. About as much water is wasted as is used in the passage of the scoop. There are two methods of warming the water, one by blowing live steam through it at intervals, and again by placing a sumphole in the center and drawing the water through a suitable pump, forcing it through a heater and returning to the track tank at the ends."

The Southern Pacific has just placed orders for 51 new locomotives of several different types. The Schenectady Locomotive Works will build 25, and the Cooke Locomotive Works will build 26.

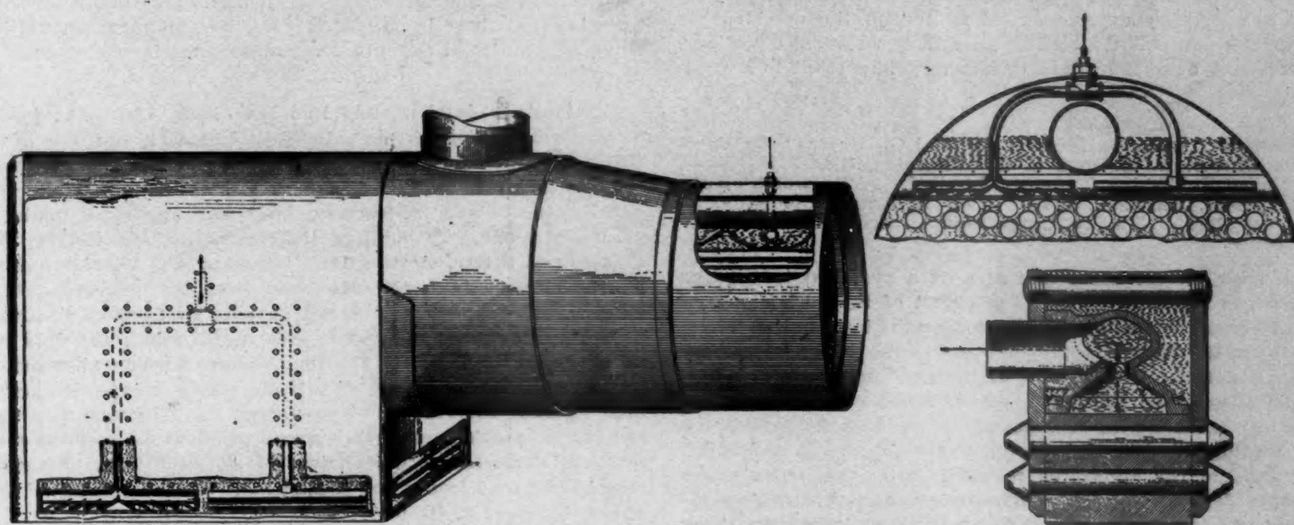
## THE HORNISH MECHANICAL LOCOMOTIVE BOILER CLEANER.

Our engravings illustrate a boiler cleaner for locomotives which has been developed by Mr. F. W. Hornish of Chicago, Ill., and the arrangement shown is applied in such a way as to permit of removing the scale forming compounds of the water without interfering with the operation of the engine, and, we are also informed, without the necessity for the removal of the apparatus in the ordinary repairs to the boiler. The devices are a skimmer placed above the tubes and near the front end of the boiler and attachments placed in the water legs and connected to the blow-off cocks, as indicated in the engraving. No compounds are used in connection with it, and the object of the arrangement is to remove the solid matter from the water as it is separated from the feed-water by the heat.

The skimmer is placed as far forward in the barrel of the boiler as the braces will permit. It faces the cab and reaches from side to side of the boiler and between the top of the flues and the top of the boiler, allowing a space for the dry pipes to pass through. The skimmer is placed in line with the natural circulation of the boiler. The impurities are collected in the concave plate and are removed by blowing off without loss of water, the solid matter only being removed. It is so arranged as to make a good surface skimmer the full width of the boiler, and at the same time forms a basin of about 25 gallons capacity to hold the sediment.

The parts which are placed in the water legs can only be applied when the boiler is built or a new firebox put in. The device is the same that empties the skimmer and it is placed upon the mud ring. The sectional view shows the water passages, and what Mr. Hornish calls "suckers" face the mud ring, above which they are raised one-half inch. The size of the openings varies with the distance from the center, this being done to prevent the openings nearest the center from drawing more than their share of the sediment. The devices do not interfere in any way with the ordinary methods of cleaning or washing out, and experience substantiates the claim that they prevent boilers from foaming. The cleaner operates whenever there is circulation in the boiler. Mr. Hornish draws attention to the fact that the method of washing out boilers while the sheets are hot is not only destructive, but also tends to cause the scale to adhere to the plates.

The interesting feature of this device is that it appears to do its work admirably, and as foaming is eliminated the danger of carrying solid and gritty matter into the valves and cylinders is avoided. In a case where the water is very bad a great improvement has been found in the prevention of leaky flues and in the repairs necessary to the boiler, as well as in the losses from the use of a large amount of water in washing and in blowing off. When applied to a locomotive on the Chicago & Northwestern Railway it was found to more than double the distance which the engines could run before being washed out.



The Hornish Mechanical Locomotive Boiler Cleaner.

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The strong commercial position given this country by its ability to manufacture steel cheaply and in large quantities, is bound to be very generally recognized in the near future. The use of labor-saving machinery, combined with intelligent labor, is the reason. We have referred to the invasion of foreign countries with American steel, and now, from Mr. Andrew Carnegie, comes the following statement concerning the position of Pittsburg in the steel industry: "There is not a district in this world to which the Pittsburg district cannot to-day send steel and pay the freight and deliver that steel as cheap or cheaper than it can be made at the point of delivery, if we except Colorado, to which the freight is greater than the difference in cost of manufacture at the two points. Should the South be successful in its present attempt to manufacture steel, we may have to except another point. Colorado excepted, the Pittsburg district has the whole world to-day at its feet. Pittsburg is indeed the steel city."

## BOOKS AND PAMPHLETS.

Handbook of Corliss Steam Engines. By F. W. Shillitto. 197 4¾x6¼ inch pages, with 60 illustrations. The American Industrial Publishing Company, Bridgeport, Conn. Price, $1.

This is a book which, while especially concerned with the installation of Corliss steam engines, will be valuable to all those who have occasion to set up engines, whether of this type or not. The treatment of the subject is comprehensive and complete, and there is much in it that will be valuable to the owners and engineers of Corliss engines. Engineers will be particularly interested in a chapter in which the author describes his experience with these engines. The application of the indicator has not been as fully treated as many will wish, but the directions for setting foundations and erecting and lining up the engines and setting the valves are its strong points.

Commercial Relations of the United States with Foreign Countries During the years 1896 and 1897. In two volumes. Vol. I. Issued from the Bureau of Foreign Commerce, Department of State (formerly Bureau of Statistics). Government Printing Office, Washington, 1898.

This valuable volume contains a review of the commerce of the world and information based upon consular reports concerning the commercial relations between the United States and other American countries, and Africa, Asia, Polynesia and Australia. Aside from statistics, a great deal of information is given to those concerned in foreign trade. The work of compilation and classification was done under the direction of Mr. Frederic Emory, Chief Bureau of Foreign Commerce.

**Up to Date Air Brake Catechism. A Complete Study of the Air Brake Equipment, Including the Latest Devices and Inventions Used. All Troubles and Peculiarities of the Air Brake and a Practical Way to Find and Remedy Them Are Explained. By Robert H. Blackall, Air Brake Instructor, Delaware & Hudson RR. Illustrated by engravings and two large folding plates. Pages, 230. Norman W. Henley & Co., 132 Nassau Street, New York, 1898. Price, $1.50.**

The author's object as stated in the preface is to present a complete, up to date study of the air brake, so written as to give the rudiments to those who want them and the complete details for more thorough students. The arrangement in the form of a catechism assists in clearness and is undoubtedly well adapted for the men who will read it most—trainmen, enginemen and those who come into contact with brakes, and especially those who must pass examinations in the principles and operations involved. The system described is the Westinghouse, and it is well and completely described, although many will want to see the high speed brake more completely illustrated. The subjects of inspection, repairs and operation are well handled, and the author's experience makes him an authority, and his methods of explaining the operation of the triple and engineer's valves show that he is accustomed to describe them in simple, concise terms. It is a good instruction book and is also valuable for reference by those who do not study it through. It is the best book of the kind that we have ever seen. The author probably had enginemen, shopmen and air brake instructors specially in mind, but it should be procured and read by every railroad man from the president to the car inspector. After testing the index in several directions, it seems to be excellent, and this is very important in a work of this kind.

A Practical Treatise on Modern Gas and Oil Engines, by Frederick Grover, A. M. Inst. C. E. Second edition, 250 pages. Technical Publishing Company, Limited, 31 Whitworth street, Manchester, England, and D. Van Nostrand Company, 23 Murray street, New York, publishers. Price, four shillings six pence.

This book, as the name indicates, is a practical treatise on modern gas and oil engines. The object of the author was to assist mechanical draftsmen in obtaining the information necessary to enable them to apply their art to the design of gas engines. A general arrangement of the gas engine plant is first described; then the different types of modern gas engines are taken up, together with explanations of methods for calculating their leading dimensions. An important feature is a detailed description of the apparatus required and the calculations necessary for complete gas engine trials, and this subject includes a chapter on the practical analysis of gases. The book concludes with a description of a series of experiments made to determine the effect of the products of combustion when present in explosive mixtures of coal gas and air. This book has been received with special favor, making it necessary to follow the first edition in a short time with the one before us, and this is the best test for a successful book. This is the best book that we have seen on gas engine design, and it is apparent that the author is a master of the subject.

We take this opportunity to state that the books of the Technical Publishing Company of Manchester may be obtained of Messrs. D. Van Nostrand & Company.

"A Catechism of the M. C. B. Rules of Interchange." Issued by the McConway & Torley Company, Pittsburg, Pa. Pages, 40; illustrated, 1898.

This convenient little book contains 100 questions and answers concerning the M. C. B. rules of interchange of freight cars. It follows the plan adopted by Mr. M. N. Forney in his catechism of the locomotive. The book is illustrated by the diagrams that appear in the interchange rules, and at the end a series of plates showing the product of the McConway & Torley Co. are included. The idea of the book is a good one. It is intended as an aid to car inspectors and incidentally to direct attention to the merits of the Janney coupler and the other devices manufactured by this company. It is valuable to the men who inspect cars, and will be appreciated. Copies will be sent free on application to the company. The edition for general circulation is bound in leather board to match the books of rules issued by the Master Car Builders' Association. We are glad to have a copy in our library, as an aid to the interpretation of the rules.

Statistical Year Book of Canada for 1897. Issued by the Department of Agriculture, 1898.

Bulletins of the United States Geological Survey, Nos. 88, 89 and 149.

United States Geological Survey Monograph on Fossil Medusæ, by Charles Doolittle Walcott, Government Printing Office, Washington, 1898.

Report of Board of Mediation and Arbitration of the State of New York, Eleventh Annual Report, 1898.

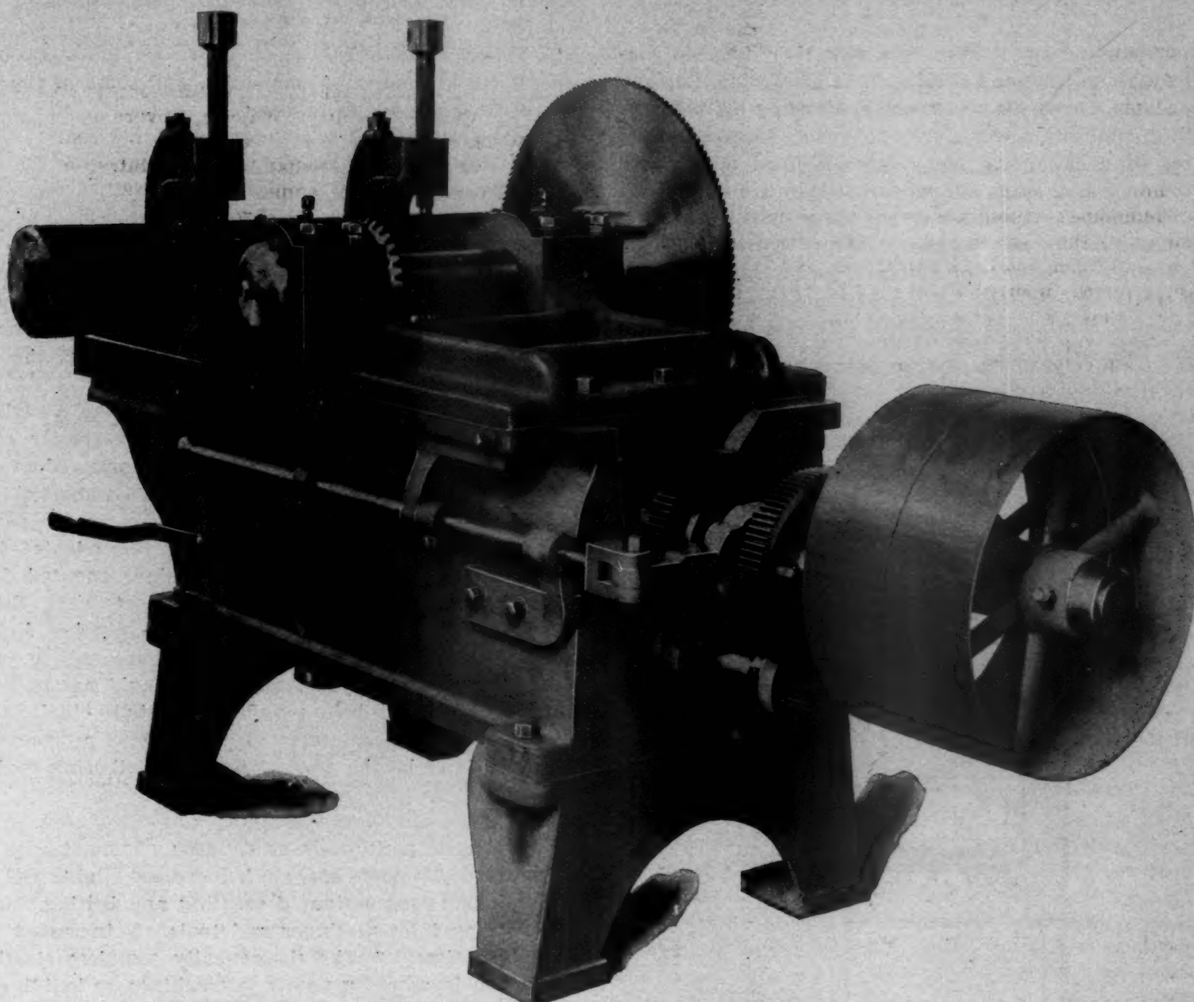
"The Modern Roundhouse Turntable" is the title of a handsome twelve-page pamphlet received from the Westinghouse Electric and Manufacturing Company. It contains excellent engravings, and a clear, brief description of the Westinghouse method of operating locomotive turntables by electric motors. In our June issue of 1897, page 191, the system was illustrated and described in its application on the Chicago, Milwaukee & St. Paul Railway, and in the December issue of the same year, page 416, we described a similar plan in use on the Baltimore & Ohio Southwestern. In both of these cases, as well as in the pamphlet under review, the possibilities for saving in the cost of labor are stated in plain figures. The Westinghouse method of applying electricity to the operation of turntables should be specially interesting to railroad managers, inasmuch as it requires no change in the turntable itself except to attach the drawbar lug to the girder of the table. The motor is simple in its attachment, and the saving to be had is practically all clear gain, because there is no reason why the apparatus should involve any material expense for maintenance in many years.

Electrical Trades Directory and Handbook, 1899. The forthcoming new edition of this valuable publication, which is in its 17th year, will contain a carefully compiled list of British, colonial and foreign electricians, electrical engineers, electric light engineers and contractors, electrical apparatus makers, plant and machinery builders, instrument makers, electric bell makers and fitters, electric light, telegraph and telephone companies, electric light, telegraph and telephone engineers, wire makers and drawers, and of all persons engaged in electrical pursuits throughout the world; also, useful tables and data relating to electric light and traction, electric power transmission, telegraphs and telephones, electricity supply companies, home and foreign government departments. A biographical section gives particulars of the careers of about 320 eminent men who are connected with electrical development. The directory may be obtained from "The Electrician," Salisbury Court, Fleet street, London, E. C., price, 12 shillings.

Baldwin Locomotive Works. Record of Recent Construction. No. 8.

This is the eighth pamphlet in the series, regularly issued by the Baldwin Locomotive Works to illustrate and describe locomotives recently built by them. In it we find a ten-wheel engine for the Atlantic Coast Line, a compound consolidation for the Ottawa, Arnprior & Parry Sound; a six-coupled double ender and a compound of the same type, for the Government of Victoria; a compound consolidation and a compound six-coupled engine for the Chinese Eastern, a mogul for the United States of Columbia, a compound consolidation for the Moscow-Windau-Ribinsk Railway of Russia, and a number of light engines for foreign roads, among which is a double ender for the Lynton & Barnstable Railway, England. The general dimensions and excellent half-tone engravings of each design are given.

Waterman's Ideal Fountain Pen.—A very attractive catalogue has just been received from Mr. L. E. Waterman, describing and illustrating the large number of his well known pens. The pen itself needs no commendation where it is known, but for ease in ordering we recommend readers to send for a copy of this pamphlet. After a decidedly unsatisfactory experience with a number of kinds of fountain pens we obtained one of these, and have found it so perfectly reliable that we are glad to take this opportunity to testify to the success obtained by Mr. Waterman. Upon selecting a pen which suits the hand we believe that our experience will be corroborated by everyone who orders from this catalogue.



Power Sawing Machine.—Q & C Company.

## SAWING MACHINE AND SAW GRINDER.

By the Q & C Co.

The use of cold saws is extending, and a great deal of work formerly done upon planers is now more satisfactorily treated by saws. An example was seen recently at the Juniata shops of the Pennsylvania Railroad, where expansion pads are being cut off obliquely at the ends by a saw, to the relief of the planer.

The Q & C Co. have introduced the machine shown in the accompanying engraving, which is No. 11, and also an automatic grinder used in connection with it, in order to keep the saws in proper condition. This particular machine, No. 11, is intended for cutting large quantities of steel rails, bar iron and steel shafting, ranging in size from 3 to 8 inches. The saw blade is 25 inches in diameter and ¾ inch thick, the saw being driven by the arbor. When it is desired to cut large quantities of such material a special chuck is used, which will hold from 3 to 6 pieces at a time, the purpose being to save time in clamping the work. A series of tests recently made in cutting steel rails showed that the saw would make 160 cuts with scarcely a perceptible dullness of the blade.

The weight of the machine is about 3,000 pounds, and it occupies a floor space of 2½ by 7 feet. The saw blade makes 11 revolutions per minute, the cutting speed is 7-16 inch per minute, and the travel of the saw carriage is 10 inches. The machine has a quick return of the carriage after completing the cut.

The automatic grinder is used to resharpen the saws, and it will work with very little attention and give a correct form of tooth. The construction of the machine and the method of attaching the saws thereto is clearly indicated in the engraving.

The address of The Q & C Co. is 700 Western Union Building, Chicago, Ill.

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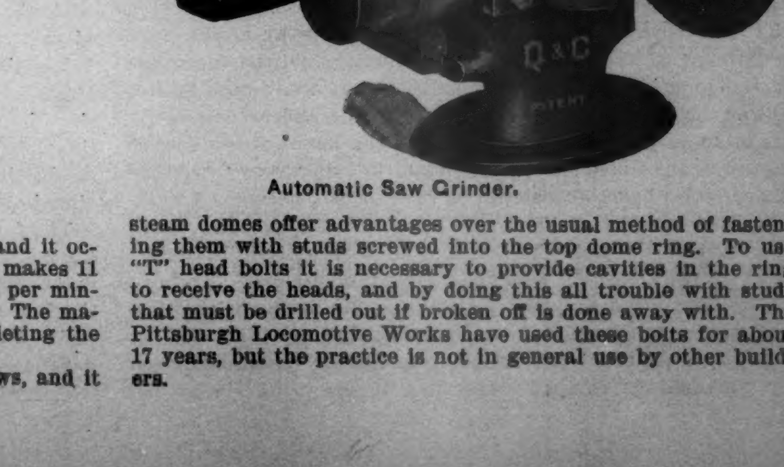
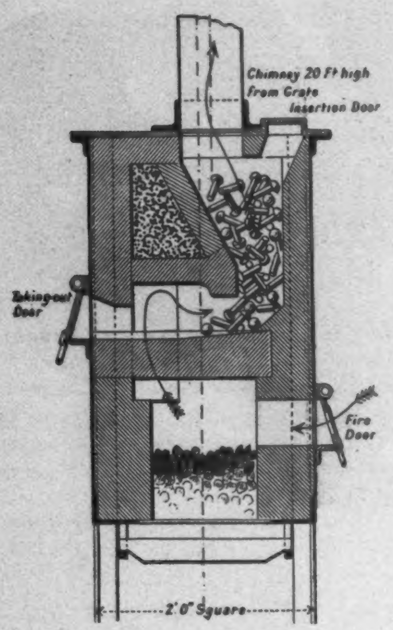
Bolts with "T" heads for holding down the top castings or steam domes offer advantages over the usual method of fastening them with studs screwed into the top dome ring. To use "T" head bolts it is necessary to provide cavities in the ring to receive the heads, and by doing this all trouble with studs that must be drilled out if broken off is done away with. The Pittsburgh Locomotive Works have used these bolts for about 17 years, but the practice is not in general use by other builders.




Automatic Saw Grinder.

## CONTINUOUS RIVET FURNACE.

The accompanying cut illustrates a new rivet furnace constructed by Messrs. Ross and Gibson, of 68 Cheapside, London. The furnace has a fireplace below, communicating by means of ports with a combustion chamber, into which opens a hopper surmounted by a chimney. The hopper is filled with rivets through the door at the top, and when hot they are withdrawn through the combustion chamber by the upper door in the side. Thus the flame on its way to the chimney is drawn by the draught through a column of rivets 9 inches or 10 inches high, and while those at the bottom of the hopper are ready for use, those at the top—if the supply of rivets be kept up—will always be nearly cold.



A Continuous Rivet Furnace.

Air is admitted through a regulator in the fire door to insure perfect combustion of the gases before they reach the rivets, and plenty of room is given in the combustion chamber for thorough mixture of the air with the gases. If properly worked, the furnace makes no smoke. When rivets of different lengths are wanted they are put in the hopper in layers and preserve their relative order in their descent through the hopper. Special rivets may be put into the combustion chamber through the extraction door. The furnace may be easily moved from place to place."—"The Engineer."

## ELECTRIC MOTORS FOR RAILROAD SHOPS.

That electricity is destined to supersede every other means of general power distribution is no longer a matter of doubt in the mind of anyone who has made a study of the matter, even in the most cursory manner. Tests made by many of the most prominent engineers of the country during the past few years have demonstrated the fact that the usual or average loss of power through the employment of shafting and belting is not far from 40 per cent. In some shops the losses are as low as 25 per cent., but, on the other hand, in other heavy machine shops losses have been shown as high as 80 per cent. A notable demonstration of the heavy loss prevailing in some shops was that of the Baldwin Locomotive Works of Philadelphia, prior to the time that this company adopted electric motors.

The Consulting Engineer for the Baldwin people at the time the matter was taken up was Professor J. J. Flather; and his report, to the effect that 80 per cent. of the power employed by the Baldwin company was used in operating shafts and belting alone, led to the immediate installation of electric motors.

Professor Flather has made numerous investigations and reports for a number of companies, and some of the notable records of losses are as follows:

Hartford Machine Screw Company, 25 per cent.
Pond Machine Tool Company, 41 per cent.
Yale-Towne Company, 49 per cent.
Bridgeport Forge Company, 50 per cent.
Baldwin Locomotive Works, 80 per cent.

Many examinations other than those enumerated have been made by Professor Flather, and while in some shops where light machinery is used and almost constantly employed, losses were found to be as low as 25 per cent., the general average as reported was 42.3 per cent.

Small wonder is it then that the value of the electric motor is universally recognized, and that it is generally conceded that machine shops of every description must adopt electric motors or find themselves far behind in economical production.

The question as to the type of motor best adapted for conditions in a given shop is wholly a minor one and does not affect the general proposition of their necessity. Engineers frequently disagree on the question as to whether direct-connected or geared motors should be employed, or whether motors for given groups of machines should not be belted to shafting from which belts may be run to individual machines; but there is no disagreement on the general proposition that electricity is to be the general power distributing medium of the future.

Briefly enumerated, the advantages accruing from the adoption of electric motors are as follows: 1. Saving in power. 2. Economy of floor space. 3. Increased light and cleanliness, due to elimination of shafting and belting. 4. Wider range of speed for machines and tools. 5. Increased product in a given time. 6. The theoretically complete elasticity of the system in carrying power to machines or buildings more or less remote from the point of generation of power, notably where additions are made to shop buildings or plants.

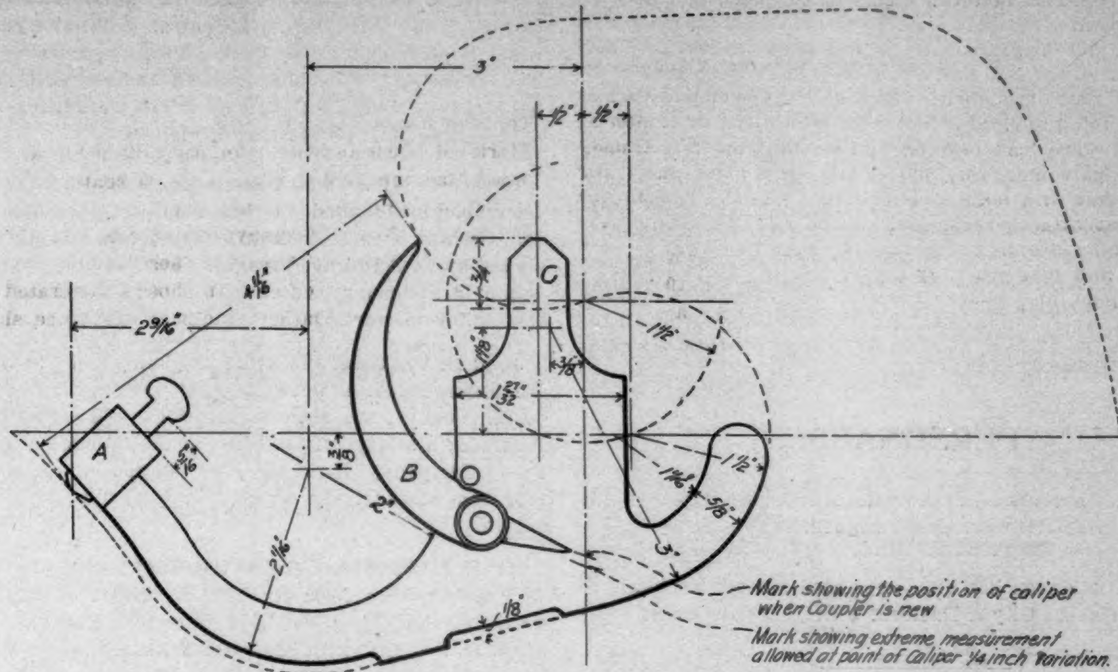
The "American Engineer," recognizing the absolute truth of the statement of advantages noted above, will devote considerable space in the future to electric motors and motive power for railroad shops, and to this end will endeavor to cover the subject completely in its columns. The matter will be taken up fully and in technical detail, and arrangements have already been made to publish plans and shop costs of railroad plants already operated by electric motors.

## A NEW COUPLER GAUGE.

A coupler gauge that is most admirably adapted to its purposes is shown in the accompanying engraving. It was designed by Mr. Thomas Fildes, division master car builder, at Chicago, of the Lake Shore & Michigan Southern Railway. We give a drawing of the gauge with a superimposed outline (in dotted lines) of the coupler contour. It will be seen that the gauge sets firmly into the face of the jaw, and in so doing presents three points for gauging, A, B and C. At A the outer arm of the gauge carries a flat graduated pin, with a sliding fit. When the guard arm becomes so deformed or out of line that this pin will pass through the gauge when applied up to the shoulder of its head—a distance of five-sixteenths of an inch—the permissible safe variation from contour is indicated. The graduations on the pin show during inspection from time to time how close to the safe limit the variation is proceeding.

The function of the caliper B is clearly shown by the drawing and its legend. A mark on the body of the gauge shows by register with the indicator end of the caliper, the position of the knuckle face from normal up to a quarter inch variation, which latter, with the five-sixteenths at A, is the permissible extreme—which is 5¼ in. from edge of knuckle to guard arm.

The projecting arm, or point C, is used as an alternative with




A New Coupler Quage to Show Allowable Wear.

or check upon the caliper. When the gauge is set as shown, this projection, C, rests upon the top of the knuckle, and when the latter is so far out of its proper position that this projection will drop inside the knuckle, the permissible safe variation at this point, three-quarters of an inch (which is the practical equivalent of the variation of one-quarter inch at the point of the caliper, before explained) will have been reached. The large dimension of this projection C—one and twenty-seven thirty-seconds of an inch—is used for gauging the diameter of the pivotal pin holes.

This gauge has proven its worth and its complete efficiency in daily practice.—"The Railway Master Mechanic."

## "CUPPED" FIREBOX SHEETS.

The method of pressing the side sheets of locomotive fireboxes into cup-formed depressions at the stay bolt which was first brought out by the Chicago, Rock Island & Pacific, has now been used long enough to demonstrate its advantage in some directions, and to show that there are no attendant disadvantages. The breakage of staybolts and their weeping or incipient leaking go hand in hand, and arise from the same cause, the unequal movement of the firebox sheets due to expansion and contraction. The weeping around the staybolts has been entirely overcome by the cupping process, and while the breakage of the bolts seems to have been improved conservative people will wait for longer experience before expressing positive opinion on this point.

The process of cupping the sheets was described in our issue of September, 1897, page 321. The side sheets only are so treated on the Rock Island, but other roads in their experiments have extended it to the crown sheet also. The effect of the cup seems to be to provide means for the sheet to "give and take" at each staybolt, and as the inside firebox sheets move under changes of temperature a portion of the motion is taken up in the sheets themselves to the relief of the bolts from a part of the bending to which the destruction of staybolts is now generally attributed. The sheets as a whole seem to be stiffer than when flat, but there also appears to be an opportunity for local bending in a transverse direction from which the relief is found. It is seen to be advantageous to use thin firebox sheets when cupped, and better results have been obtained with 5-16-inch than with 3/8-inch sheets.

The effect of the fire impinging on the heads of the staybolts in the side and end sheets under ordinary conditions has been to reduce their life, and to cause the sheets to be eaten away around the heads, causing leakage. The immediate remedy is naturally to rivet the heads a little tighter, but this when carried too far causes other troubles. The eating away that is referred to does not appear to be explained by leakage at the bolts, because in some cases leakage is a result rather than a cause of it. The cupping, in which the sheets are bulged outward at the staybolts, serves to defend the heads from the fire and this trouble stops.

At the Rock Island shops the cupping is done by the hydraulic punch. The sheets are laid out with prick punch marks for the staybolts, and after the cupping the sheets are drilled. They are annealed to overcome the local internal stresses that may be set up by the cupping. The form of the punch and die is shown in the description already referred to. An interesting experiment was recently tried to show the effect of the cupping upon the tensile strength of the plate. A narrow plate of firebox steel was cupped and "pulled" in a testing machine. It was expected that the break would occur through one of the cups, but the plate always broke in the straight parts.

## LEAD AND ZINC PAINTS.

A series of exposure tests of lead and zinc paints are reported in a recent issue of the Railroad Gazette by Mr. G. R. Henderson, with the following results:

Tin.—The best results were obtained with first coat white lead and second coat white zinc. The second coating of zinc gave generally the best results, and the second coating of lead the worst.

Galvanized Iron.—The same remarks apply to galvanized iron that were given for tin.

Sheet Iron.—The mixture of one-third white zinc and two-thirds white lead, for both coats, gave the best results on this material, and in general the zinc paints gave better results than the lead paints.

Poplar.—The second coats of zinc showed up well on poplar, no matter whether the priming coats were white lead or white zinc, or mixed lead and zinc. The lead second coating showed up the worst on this material, but in each case where the second coat was of zinc, totally or partially, the paint was in a perfect condition.

White Pine.—The remarks made relating to poplar apply to white pine also.

Yellow Pine.—This material seems to be difficult to properly treat with paints; the best results were obtained with the first coat of lead, and the second coat of lead and zinc mixed. Where the first coat was of lead and zinc mixed, or entirely of zinc, the results were poor throughout, which seems to indicate that as as a general thing the lead is better for priming on this material.

Conclusion.—The lead priming and zinc coating is generally good for tin, galvanized iron, poplar and white pine. Sheet iron showed up best with both coats of mixed paints. Yellow pine appeared best with the first coat of lead and the second coat of lead and zinc mixed. Comparing the materials which were painted, we find that generally poplar retains the paint better than white pine, and would, therefore, be preferred for siding on buildings, etc., Yellow pine seems to be the worst of all for this purpose. Black iron, as a whole, seems to retain the paint better than either tin or galvanized iron.

## PERSONALS.

Mr. G. D. Churchward, Locomotive Superintendent of the Imperial Chinese Railways, has resigned.

Mr. A. C. De Haven has been appointed Master Mechanic of the Omaha, Kansas City & Eastern, with headquarters at Stanberry, Mo.

Mr. H. E. Clacas has been appointed Master Mechanic of the Atchison, Topeka & Santa Fe at La Junta, to succeed Mr. John Forster, Jr., resigned.

Mr. Darius Miller, formerly Vice-President and Traffic Manager of the Missouri, Kansas & Texas, has been appointed Second Vice-President of the Great Northern.

Mr. Norman E. Sprowl has been appointed Division Master Mechanic of the New Jersey Central division of the Central Railroad of New Jersey, with office at Elizabethport, N. J.

Alfred Skitt, General Manager of the New York Central's lighterage department, has been elected Vice-President and a Director of the Manhattan Elevated Railroad Company, of New York.

Robert H. Harrison, foreman of the Pittsburg, Fort Wayne & Chicago shops, at Fort Wayne, and for 40 years in the service of the Pennsylvania, has been retired, with full pay, for the remainder of his life.

Mr. John Medway, formerly Superintendent of Motive Power of the Fitchburg Railroad, has been appointed Master Car Builder of the Swift Refrigerator Transportation Company. His headquarters are in Chicago.

William H. Schoenberger died in Cobourg, Ontario, Oct. 16 at the age of 62 years. He was connected with the Schoenberger Steel Company of Pittsburg for a time and afterward associated himself with Messrs. Schoenberger, Blair & Company.

Mr. F. M. Stevens, a brother of Mr. George W. Stevens, Superintendent of Motive Power of the Lake Shore, has resigned his position as General Foreman of the Sormovo Locomotive Works at Nijni Novgorod, Russia, to take a position with the Baldwin Locomotive Works. He was connected with these works some years ago.

Mr. W. C. Ennis, who was for many years Master Mechanic and Master Car Builder of the New York, Susquehanna & Western R. R., has connected himself with the Chicago Pneumatic Tool Company, with headquarters at the New York office. Mr. Ennis enjoys a wide acquaintance among the railroad men of this country, and will be a valuable addition to the staff of the Chicago Pneumatic Tool Company.

Mr. J. S. Turner has resigned as Superintendent of Motive Power of the West Virginia Central & Pittsburgh Ry. to become Superintendent of Motive Power of the Union Pacific, Denver & Gulf, with headquarters at Denver, Col. Mr. Turner's many friends will join us in congratulating him on this advancement and recognition of his ability.

Horace B. Miller, who was one of the founders of the "American Machinist," died of heart failure at Napa, Cal., Oct. 25. He was born in 1839 in Philadelphia, and during the war served under Admiral Farragut. His first newspaper work was begun in Pittsburg, and in 1877 he was associated with Jackson Bailey in starting the "American Machinist."

John H. Dialogue, the noted shipbuilder of Camden, is dead. He began machine work in early life and took care of the repair work of the locomotives of the old Camden & Amboy Railroad; also that of the boats of the Camden & Philadelphia Ferry Company. He entered the shipbuilding business about 1860 and was actively engaged in it during the remainder of his life.

Mr. H. H. Vaughan, Mechanical Engineer of the Philadelphia & Reading, who formerly held a similar position with the Great Northern, has just been appointed Mechanical Engineer of the Q. & C. Co., with headquarters in Chicago. Mr. Vaughan has an excellent standing in his railroad work, and, while he is greatly needed in that field, his continued success is assured either on or off a railroad, and we consider anybody who secures his services as subject to congratulation.

William B. Snow, who was formerly Master Mechanic of the Illinois Central, died in Chicago Oct. 21, aged 77 years. He began railroad work in 1844 at Bellows Falls, Vt., as foreman of bridges and buildings of the Western Railroad of Massachusetts, and was in the car department of that road for two years. In 1848 he became connected with Tracey & Fales, car builders at Hartford, Conn., and in 1850 he took a position with the American Car Company, Seymour, Conn. In 1857 he became general foreman of car work for the Illinois Central and remained there 15 years. After 1872 he was for three years traveling mechanical inspector for the Pullman Company, and from 1875 to 1891 he was Master Mechanic of the Illinois Central.

William M. Wilson, president of the Fox Pressed Steel Equipment Company, died in New York November 17, after a surgical operation. Very few men have more friends among prominent railroad men than Mr. Wilson had, and the news of his death will be a shock to those who saw him apparently enjoying excellent health only a short time before his death. His circle of friends was widened by his connection with the Fox Pressed Steel Company, and at different times with other steel interests, among which were the Otis Steel Company, of Cleveland; the Carbon Steel Company and the A. French Spring Company, of Pittsburgh, and the American Coupler Company.

Captain W. W. Peabody has tendered his resignation as Vice-President of the Baltimore & Ohio Southwestern, which he decided to do on account of failing eyesight, and he will retire from active railroad work, although he continues to be a director in the company. He is 62 years of age and has been in railroad work since 1852, when he entered the service of the Marietta & Cincinnati, now a part of the Baltimore & Ohio Southwestern. Since that time he has been successively assistant engineer, president's private secretary, paymaster, master of transportation, superintendent and general manager. From 1877 to 1880 he was general superintendent and general manager of the Ohio & Mississippi Ry., and from 1883 to 1886 president and general manager of the same road. From 1887 to 1890 he was manager of the Trans-Ohio division of the Baltimore & Ohio, at Chicago. In 1890 he was elected vice-president of the Baltimore & Ohio Southwestern and in 1893 became vice-president under the consolidation.

**EQUIPMENT AND MANUFACTURING NOTES.**

The purchase of the Rhode Island Locomotive Works by Mr. Joseph Leiter of Chicago is reported to have been concluded.

We are informed that Messrs. J. G. White & Co., of 20 Broadway, New York, are taking bids on electric railway equipment to go to Australia.

Chicago Grain Doors and Security Lock Brackets have been furnished by the Chicago Grain Door Company for the 500 cars now building by Messrs. Wells & French for the "Soo Line."

The business of the John Stevenson Company has gone into the hands of receivers. Messrs. A. A. Wilcox, of Paterson, N. J., and Louis Stern, of New York, will act, temporarily, in that capacity. The assets are stated to be $1,175,776, and the liabilities $788,782.

The Stirling Company of Chicago has just received an order for water tube boilers for the Russian warships now building by the Cramps, at Philadelphia. It is the largest order for water tube boilers ever placed in the United States and covers 35,000 horse power.

The Illinois Steel Company has commenced the manufacture of bridge and structural steel on a large scale, at its South Chicago plant, and has become a competitor for the Carnegie works for foreign orders. The new $1,000,000 slabbing mill has greatly increased the capacity of this plant for these products.

Arrangements have been made for the absorption of the American Brake Co. by the Westinghouse Air Brake Co., the lease of the former by the latter being surrendered and the equipment and property of the American Company being transferred in fee simple to the Westinghouse people.

J. A. Fay & Co., Cincinnati, Ohio, the largest manufacturers of high grade wood-working machinery, have just sent us a folder printed in red and green illustrating about fifty of their most recently improved machines for working wood. A copy of the folder may be obtained free on application by mentioning this journal. Those in charge of wood-working shops should take this opportunity to ascertain whether they are up to date.

The Chicago Pneumatic Tool Company reports a very satisfactory state of business. In spite of the greatly increased facilities, there is difficulty in supplying the demand for their pneumatic tools and appliances. The principal increase is in the demand for the Boyer pneumatic hammers, riveters and drills. The use of these tools in railroad shops is increasing as their merits in labor saving are becoming appreciated. There is a demand for these tools in manufacturing plants and in the shipbuilding and bridge works, especially for riveting.

The 30 new freight locomotives ordered by the Receivers of the Baltimore & Ohio Railroad about three months ago, 20 of which are from the Baldwin Locomotive Works and 10 from the Pittsburg Locomotive Works, have been delivered and are now in service. These engines are of the same type that have been very successfully used on the second division between Cumberland and Baltimore, and over one hundred are now in service. They are the consolidation type, with 21x28-inch cylinders, and were constructed from designs furnished by the Motive Power Department of the Baltimore & Ohio Railroad.

The William R. Trigg Co. of Richmond, Va., has shown remarkable activity in making preparations for building the torpedo boats and destroyers recently contracted for with the Navy Department. Through Mr. John W. Duntley, President of the Chicago Pneumatic Tool Co., a contract has been signed for supplying a complete pneumatic tool plant, incuding the compressor. Pile driving has already commenced, and the buildings are nearly completed. Those who have predicted that the plant would not be ready in time to satisfy the requirements of the Government are likely to be disappointed.

Mr. Samuel M. Vauclain, Superintendent of the Baldwin Locomotive Works, and designer of the Vauclain compound locomotive, addressed the students of Purdue University, Lafayette, Ind., Nov. 12. His subject was "The Compound Locomotive." Among other things, Mr. Vauclain showed how closely the service tests which he had made on Vauclain compound locomotives agreed with tests made at Purdue.

Some unique samples of cast steel worked cold into the form of pitchers are to be seen at the office of Mr. W. S. Calhoun, Eastern representative of the American Steel Foundry Company, Havemeyer Building, New York. The pitchers will hold about three quarts, and they are made of the same quality of steel that is put into the bolsters and other railroad castings made by this concern, and this work shows the degree of refinement that has been reached in casting steel. The pitchers were pressed cold, by the St. Louis Stamping Company, from sheets rolled out from ingots, and we are informed that nearly 100 of these pitchers were stamped without breaking the metal, which is a severe test of the material.

During the past summer the Joseph Dixon Crucible Company of Jersey City, N. J., have added an extension to their pencil factory, 40 by 90 feet, three stories high. It is driven by electric power from a generator placed in the main factory. No expense has been spared in the equipment in the way of up-to-date elevators, furnaces, dry-rooms, etc. The company will also put down an artesian well, several hundred feet in depth, for a supply of water for factory use, and some time during 1899 various other additions will be built to the Dixon Company's already extensive plant. The company was established in 1827, and the volume of business for 1898 has surpassed that of any other year, and the concern is behind its orders in all departments. Because of the variety of its products and their use in many different industries, this may be considered as indicating the satisfactory condition of many business interests.

The Russell Snow Plow Company, Tremont Building, Boston, has recently received orders for snow plows, among which are the following: From the New York Central, one wing elevator snow plow No. 2, and one standard snow plow No. 2, for the Western Division, and two wing elevator snow plows of the same size for the Rome, Watertown & Ogdensburg line. From the Saginaw, Tuscola & Huron Railroad an order has been received for a No. 3 snow plow with air flangers, and from a new road in Maine, the Washington County Railroad, for one No. 4 and one No. 3 plow, with hand flangers. Russell snow plows have also been ordered by the Grand Rapids & Indiana, the Chicago & West Michigan, the Detroit, Grand Rapids & Western, each having ordered a Russell wing elevator snow plow, size No. 2. The plows for the Chicago, West Michigan and the Detroit, Grand Rapids & Western are to have the Russell air flanger attachment and Westinghouse air brakes.

Some time ago Pullman's Palace Car Company built three parlor cars for the Baltimore & Ohio New York trains, and the radical departure from other cars of this character lay in the toilet room for ladies, which was eight feet in length. Recently the same company has built eight new sleepers for the New York-St. Louis line of the B. & O. The cars are finished in vermillion wood, decorated with inlaid marquetry work and the upholstery on the backs and seats is entirely new and different from any heretofore used, being a moquette with a dark green border and a center pattern of bright color. A similar design of ornamentation has been applied to the ceiling, giving the car an arabesque effect. They are also supplied with all the modern appliances, such as wide vestibules, anti-telescoping device, air pressure water system and are lighted with Pintsch gas.

The Sargent Company has three orders for steel castings for 10-inch disappearing gun carriages for the United States Government, one to go to the Rock Island Arsenal, one to the Walker Company at Cleveland, and the other to St. Paul. Our representative happened to see a report upon one of them by the Inspector of the Ordnance Department, U. S. A., in which two specimens showed the following results:

| Tensile Strength. | Elongation. | Reduction. |
|---|---|---|
| 75,050 lbs. | 26. % | 37.3% |
| 78,450 lbs. | 27.5% | 40.4% |

The second, which showed 40.4 per cent, reduction and 37.5 per cent. elongation, is an average sample of the work of the

foundry. Besides a large amount of ordinary work on hand, two large castings of 16,000 lbs. each are being made for some heavy machinery for E. P. Allis & Co., of Milwaukee. These take an entire heat of a furnace, and show the ability of the concern to handle heavy work. The use of cast steel is extending, and the care exercised in these works gives them an excellent reputation. The orders for the "Diamond S" brake shoes keeps that department busy up to its full capacity, and Mr. W. D. Sargent reports excellent prospects of extensive use of this form of brake shoe in Europe. The general practice in England and on the Continent is to use common cast iron, and during his recent trip abroad he found foreigners interested in the progress that has been made in the development of brake shoes in this country.

## OUR DIRECTORY

### OF OFFICIAL CHANGES IN NOVEMBER.

Atlantic & Danville.—Col. Henry S. Haines has been appointed Vice-President, with office in New York City.

Bangor & Portland.—Mr. John N. Hoffman has been appointed Purchasing Agent, with office at Bangor, Pa.

Baltimore & Ohio.—Mr. L. Norvell has been appointed Assistant Engineer of Maintenance of Way of the Baltimore & Ohio at Martinsburg, W. Va.

Baltimore & Ohio Southwestern.—Mr. W. M. Greene has accepted the office of Vice-President, with headquarters at Cincinnati, Ohio, succeeding Capt. W. W. Peabody, resigned.

Boyne City & Southeastern.—Mr. Harry J. White has been appointed Master Mechanic and Superintendent of Transportation, with headquarters at Boyne City, Mich.

Chicago & Eastern Illinois.—Mr. Charles Butler has been appointed Master Mechanic, with headquarters at Momence, Ill.

Chicago Great Western.—Mr. C. E. Slayton has been appointed Division Master Mechanic, with headquarters at Dubuque, Ia.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. M. L. Sykes has been elected Vice-President and Assistant Secretary, with headquarters at New York.

Choctaw, Oklahoma & Gulf.—Mr. F. W. Valliant has accepted a position with the Engineering Department, with headquarters at Fort Smith, Ark. He was formerly Chief Engineer of the Arkansas & Choctaw.

Detroit & Lima Northern.—Mr. T. M. Downing has been appointed Master Mechanic, with office at Tecumseh, Mich., in place of Mr. J. W. Stokes, resigned.

El Paso & Northeastern.—Mr. H. A. Sumner has been appointed Chief Engineer, in place of Mr. J. L. Campbell.

Fort Worth & Rio Grande.—Mr. T. J. Shellhorn has been appointed Master Mechanic, with office at Fort Worth, Texas, in place of Mr. B. G. Plummer, resigned.

Grand Trunk.—Mr. C. H. Sutherland, Mechanical Engineer, died very suddenly a short time ago.

Grand Trunk.—Mr. W. A. Bell has been appointed Assistant Master Mechanic at Chicago, succeeding Mr. E. D. Jameson, promoted.

Great Northern.—Mr. D. Miller has been appointed Second Vice-President. He was formerly Vice-President and Traffic Manager. Mr. Miller's headquarters will be in St. Paul. Mr. F. E. Ward has been appointed General Superintendent, with headquarters at St. Paul, Minn., in place of Mr. Russell Harding, resigned.

Illinois Central.—Mr. W. B. Baldwin, Master Mechanic at McComb City, Miss., was instantly killed near Arcola, Nov. 5. He was 45 years of age, and had been connected with the road for a number of years.

Iowa Central.—Mr. Robert J. Kimball has been elected President, and Mr. George R. Morse, Vice-President and Treasurer.

Iron Mountain.—Mr. Peter Gable, Master Mechanic at Texarkana, has resigned, and has been succeeded by Travelling Engineer Beck.

Kaslo & Slocan.—Mr. Robert Irving has been elected President, succeeding Mr. D. J. Munn. Mr. George F. Copeland was elected Vice-President and Treasurer, succeeding Mr. A. Guthrie. Mr. James Jeffries was elected Secretary. The duties of the office of Secretary were heretofore performed by Mr. Robert Irving, Traffic Manager.

Manistee & Grand Rapids.—Mr. A. D. Hart has been appointed Superintendent and Master Mechanic, with headquarters at Manistee, Mich., vice Mr. W. H. Herbert, resigned.

Michigan Central R. R.—Mr. S. B. Wright has been appointed Assistant Purchasing Agent.

Munising.—Mr. Robert E. Morrison has been chosen President, with office at Munising, Mich., in place of Mr. D. P. Eels.

New Jersey & New York.—Mr. J. W. Platten has been appointed Assistant Purchasing Agent.

New York, Susquehanna & Western (Erie).—Judge W. J. Lewis, General Manager, has resigned. The duties of the office will be assumed by Captain W. A. May, Superintendent of the Hillside Coal & Iron Co., a mining company operated under the management of the Erie.

Oconee & Western.—Mr. A. F. Dailey has been chosen President. He was formerly General Counsel of the Wrightsville & Tennille.

Oregon Railroad & Navigation Co.—Mr. Henry Pape has been appointed Chief Engineer of the water lines in place of Mr. Reuben Smith, with headquarters at Portland, Ore.

Oregon Short Line.—Mr. W. D. Cornish has been elected President to succeed Mr. Samuel Carr. He was formerly Vice-President of the Union Pacific.

Pennsylvania.—Mr. J. B. Boyer has been appointed Chief Motive Power Clerk, with office at Altoona, vice Mr. B. F. Custer, deceased.

Pittsburg & Lake Erie.—Mr. Carl Zinck, Assistant Supervisor, has been appointed Assistant Engineer of Construction and Maintenance of Way, with headquarters at McKee's Rocks, Pa. Mr. Edwin F. Wendt has been appointed Assistant Engineer in charge of Maintenance of Way and Construction Work on the main line, with headquarters at Pittsburg, Pa.

South Atlantic & Ohio.—A. B. B. Harris, heretofore Acting Superintendent, has been appointed General Superintendent, with headquarters at Bristol, Tenn.

Southern California.—Mr. Paul Morton, Chicago, has been elected Second Vice-President and Mr. E. D. Kenna First Vice-President.

Southern Pacific.—Wr. W. H. Russell, heretofore Traveling Engineer, has been appointed Assistant Master Mechanic, with headquarters at Oakland, Cal.; Mr. J. C. Martin has been appointed Traveling Engineer, succeeding Mr. Russell, with headquarters at Los Angeles, Cal.

St. Louis, Chicago & St. Paul.—Mr. William H. Hale, President, has been appointed Receiver, with office at No. 27 Pine street, New York.

St. Louis, Iron Mountain & Southern.—W. H. Harris, Master Mechanic at De Soto, Mo., has resigned.

St. Louis, Peoria & Northern.—Mr. J. N. Faithorn has been elected President to succeed Mr. William E. Guy.

St. Louis Southwestern.—Mr. Edwin Gould has been chosen President. He was formerly Vice-President, and now succeeds Mr. S. W. Fordyce, who declined a re-election to the office. Mr. Russell Harding, General Superintendent of the Great Northern, has been elected Vice-President.

Union Pacific, Denver & Gulf.—Mr. J. S. Turner has been appointed Superintendent of Motive Power; Mr. B. L. Winchell, heretofore General Passenger and Ticket Agent of the St. Louis & San Francisco, has been appointed Assistant to the President of this reorganized line, with headquarters at Denver.

Wabash.—Mr. Charles H. Keiske has been transferred from Montpelier, O., to Detroit; Mr. George F. Hess, of Fort Wayne, is appointed Master Mechanic at Montpelier; Mr. G. J. Devilbiss is transferred from Andrews to Tilton; Mr. J. L. Flynn is made Foreman of the Andrews shop, and Mr. Charles L. Bond, Master Mechanic at Tilton, Ill., is transferred to Fort Wayne.

Washburn, Bayfield & Iron River.—Mr. Martin Brown has been appointed Master Mechanic, with headquarters at Washburn, Wis.

Washington County.—Mr. H. R. Robinson has been appointed Chief Engineer, with headquarters at Calias, Me. He was formerly Division Engineer at Machias, Me.

Western Maryland.—Mr. H. E. Passmore has been appointed Master Mechanic, with headquarters at Hagerstown, Md.

White Pass & Yukon.—Mr. W. H. Garlock is Master Mechanic, Mr. W. L. Wilson, Purchasing Agent, and Mr. J. W. Young, General Storekeeper. The headquarters are at Skaguay, Alaska.

Wisconsin Central.—Mr. W. Percy has been appointed Master Car Builder, with headquarters at Stevens' Point, Wis., in place of Mr. W. Cormack, resigned.